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# Muelleria

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# NEW SPECIES OF XYLOMELUM Sm. AND TRIUNIA Johnson & Briggs (PROTEACEAE)

by

D. B. FOREMAN *

## ABSTRACT

Foreman, D.B. New species of *Xylomelum* Sm. and *Triunia* Johnson and Briggs (Proteaceae). *Muelleria* 6(5): 299-305 (1987). — *Xylomelum cunninghamianum* sp.nov. from inland northern New South Wales and southern Queensland and *Triunia erythrocarpa* sp. nov. from north-eastern Queensland are described with notes on distribution, ecology and diagnostic features. The misapplication of the name *Xylomelum salicinum* is discussed.

## XYLOMELUM Sm.

**Xylomelum cunninghamianum** D. Foreman, sp. nov.

[*X. salicinum* auct. non (Meisn.) Cunn. ex Benth. (1870): Benth., Fl. austral. 5:408 (1870) *pro parte quoad* Leichhardt, and Lau; F. Muell., S. Sc. Record, n.s., 2: "unpaged pre-print" (Mar. 1886).]

"*X.* sp.", Jacobs & Pickard, Pl. New S. Wales 182 (1981); Stanley & Ross, Fl. S.E. Qld 2:17 (1986) *syn.excl.*

*Arbor* ad 12 m alta. *Ramuli* teretes, juventute tomentosi. *Foliorum lamina* lanceolata, acuta, pungens, ad basin anguste cuneata, 5-12.5 cm longa, 1.2-2.3 cm lata, coriacea juventute tomentosa, postea glabra; margines interdum parum sinuati, integri vel promineuter dentati praecipue apicem; nervi recti vel parum curvati, ad marginem acute ascendentes. *Inflorescentia* axillaris, 4-6 cm longa, rachis pallide ferrugineo-tomentosa. *Pedicelli* ad 0.5 mm longi. *Perianthium* 8-10 mm longum, ferrugineo-pubescens. *Ovarium* ferrugineo-tomentosum. *Fructus,* ± ovoideum, 6-9 cm longus, 3-4.5 cm latus, apice lato obtuso; pericarpium 8-15 mm crassus, lignosum. *Semen* 5-7 cm longum, 1.5-2 cm latum.

*Tree* to 12 m tall. *Branchlets* terete, tomentose on young shoots, soon becoming glabrous. *Leaves* opposite; blade lanceolate, acute, pungent at the tip, narrowly cuneate at the base, tapering gradually onto the petiole, 5-12.5 cm long, 1.2-2.3 cm wide, coriaceous, tomentose when young, soon becoming completely glabrous, drying light brown to yellowish green above, paler beneath; margin sometimes slightly sinuate, entire or prominently toothed particularly near the tip; midrib raised and prominent above and beneath; nerves 5-8 on each side of the midrib, raised on both surfaces, ± straight or slightly curved over their entire length, ascending acutely to the margin; reticulations well defined, raised on both surfaces; petiole 1-2.7 cm long. *Inflorescence* axillary, 4-6 cm long; rachis 1 mm diameter, pale ferruginous-tomentose. *Bract* subtending flower-pairs obtuse, ± broad-oblong to broad-oval, 1.5-2 mm x 1.5-2 mm, pale ferruginous-tomentose. *Floral bracts* apparently lacking. *Pedicels* to 0.5 mm long. *Perianth* 8-10 mm long, ferruginous-pubescent; limb 2.5-3 mm long, 1 mm wide. *Anthers* 1 mm long, tipped with a small gland, almost sessile. *Hypogynous glands* 4, free, ± oblong. *Ovary* ferruginous-tomentose; style ferruginous-tomentose at base, becoming glabrous towards the tip; pollen presenter ellipsoidal, c. 1 mm long. *Fruit* ± ovoid with a blunt apex, 6-9 cm long, 3-4.5 cm wide, covered with a dense, velvety indumentum of short ferruginous to grey hairs; pericarp 8-15 mm thick, woody. *Seed* 5-7 cm long, 1.5-2 cm wide; nucleus angular-obovate, 1.5-2 cm long, 1-1.5 cm wide; wing 3.5-5 cm long. (Fig 1).

TYPE COLLECTION:

4-5 km north-west of Wallangra on road to Coolatai, New South Wales, 18.viii.

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Fig. 1. *Xylomelum cunninghamianum*. a — fruiting branchlet, x 1; b — seed, side view, x 1. a & b from type collection.

1985, *D.B. Foreman 873* (fruiting collection). (Holotype: MEL 1546329. Isotypes: BRI, CANB, NSW).

REPRESENTATIVE SPECIMENS EXAMINED (Total number examined 38):

*Queensland* — Isla Gorge, 24.v.1977, *N.B. Byrnes & M. Olsen* (BRI); Blackdown Tableland, 22.ii.1982, *S.G. Pearson* (BRI); 80 km SW. of Rolleston, *I.R. Telford 5816* (BRI); Darling Downs, near Cecil Plains, 4.vi.1946, C.T. White 1175 (BRI).

*New South Wales* — 4.9 km E. of Yetman, 1.xi.1983, *P. Coveny 11651 & P. Wilson* (NSW); 4-5 km NW. of Wallangra on road to Coolatai, 18.vii.1985, *D. Foreman 880* (MEL); 12.8 km E. of Coolatai, 14.ii.1977, *G.P. Guymer 953a* (NE, NSW).

DISTRIBUTION (Fig. 2):

Scattered throughout inland regions of south-eastern Queensland and north-eastern New South Wales from the Blackdown Tableland to the Coolatai-Wallangra area.

Fig. 2. Distribution of *Xylomelum cunninghamianum* (hatched) and *Triunia erythrocarpa* (black).

ECOLOGY:

In dry sclerophyll forest or woodland on sandy soil derived from granite or sandstone. Often in association with *Angophora costata, Callitris endlicheri* and *Eucalyptus* spp. at altitudes from 350 m to 630 m. Flowering February to May; fruiting May to December.

NOTES:

The epithet honours Allan Cunningham (1791-1839), a Kew collector and later colonial botanist in New South Wales. Cunningham's connection with the present species is an interesting one, although as will be seen from the discussion below, it is a somewhat indirect one.

The name *Xylomelum salicinum* first appeared in the literature as a Cunningham manuscript name placed in synonymy under *Xylomelum pyriforme* (Gaertner) Knight by Robert Brown (1811). The first valid combination involving the name *salicinum* was made by Meisner (1856) when he recognized *Xylomelum pyriforme* β [? = var.] *salicinum (foliis elongata-lanceolatis)*. Meisner (l.c.) indicated that the type collection was a Cunningham specimen from *"circa sinum Moreton Bay"*. As far as can be determined the actual specimen concerned was collected

by Cunningham on 25 June 1829 on the Brisbane River about 88 miles (140 km) north-west of the (then) penal settlement on Moreton Bay. An examination of a colour photograph of this specimen shows that it is clearly not referrable to *X. cunninghamianum.*

The confusion of *X. salicinum* with *X. cunninghamianum* started when Bentham (1870) raised the epithet *salicinum* to specific level. His circumscription of *X. salicinum* included elements referrable to *X. cunninghamianum, X. scottianum* (F.Muell.) F.Muell. and *X. pyriforme.* Mueller (1886), while pointing out the confusion resulting from Bentham's work, also misapplied the name *X. salicinum* to specimens which have now been placed in *X. cunninghamianum.* In more recent times as the confusion became obvious *X. cunninghamianum* was referred to on some herbarium sheets as "the inland form of *X. salicinum*".

Neither of the two *Xylomelum* species from Western Australia, viz. *X. angustifolium* Kipp. & Meisn. or *X. occidentale* R.Br. are closely related to or resemble *X. cunninghamianum.* Of the eastern Australian species *X. scottianum* most closely resembles *X. cunninghamianum,* the leaves being about the same size and drying a similar colour. The overall size of the inflorescences and flowers of both these species are also similar. *X. scottianum* differs from *X. cunninghamianum* in having a cream to pale brown indumentum on its inflorescence and perianth and in having leaf blades with fewer and less pronounced veins. The fruit of *X. scottianum* also has a very characteristic acuminate distal end which contrasts with the much blunter fruit apex of all other species. *X. pyriforme* differs from *X. cunninghamianum* in being a much more robust plant with larger leaves, flowers and fruits.

## TRIUNIA L. Johnson & B. Briggs

In a recent paper (Foreman, 1986) I indicated that some specimens from north Queensland which had been referred to *Helicia youngiana* W. Hill & F. Muell. var. *robusta* (basionym for *Triunia robusta* (C. White) D. Foreman) may represent a new species. This new species is now formally described as *T. erythrocarpa.*

**Triunia erythrocarpa** D. Foreman, sp.nov.

[*Helicia youngiana* C. Moore & F. Muell. var *robusta* auct. non C. White (1933): C. White, Contr. Arnold Arbor. 4:23 (1933) *pro parte quoad* Kajewski 1219].

*Frutex* vel arbor 5-10(-20) m alta. *Ramuli* teretes, in surculis ferrugineo-tomentosi mox glabri. *Folia* opposita vel in verticillis 3-4-foliatis; lamina obovata ad anguste elliptica vel elliptica, acuminata, ad basin attenuata, 6.5-19 cm longa, 2-7 cm lata, chartacea ad coriacea, ± glabra; margines integri (in plantula dentati); nervi in dimidio infero recti ad marginem anastomasantes; petiolus 5-8 mm longus. *Inflorescentiae* terminales, ad c. 7.5 cm longae; rachis ferrugineo-tomentosae. *Bracteae* pares florum subtendentes gemmas tegentes, interdum ad anthesis persistentes, ovatae, 7-10 mm longae, marginibus ciliatis, extus glabrae, intus atro-ferrugineo velutinae. *Pedicelli* graciles, 4-6 mm longi, ferrugineo-tomentosi. *Flores* amoene odorati, albi ad cremei. *Perianthium* zygomorphum, 1.2-2 cm longum; tubum parce ferrugineo-pilosum; limbus 2-3 mm longus, ad anthesin revolutus, dense ferrugineo-pilosus. *Antherae* 4, 1 mm longae. *Glandes hypogynae* 2, liberae, oblongae. *Ovarium* dense ferrugineo-tomentosum; praebitor pollinis rhomboideus, c. 1 mm longus. *Fructus* coccineus, globosus, 1.8-3.5 cm. diam.; pericarpium semi-carnosum; semen ± globosum, c. 1.5 cm diam.

*Shrub* to tree 5-10(-20) m tall. *Branchlets* terete, ferruginous-tomentose on young shoots, soon becoming glabrous. *Leaves* opposite or in whorls of 3-4; blades obovate to narrowly elliptic or elliptic, acuminate, attenuate at the base, 6.5-19 cm long, 2-7 cm wide, chartaceous to ± coriaceous, ferruginous-tomentose when immature, becoming ± glabrous with some hairs persisting on the midrib and the undersurface, drying dark brown to olivaceous above, lighter beneath; margin entire (seedling leaves toothed); midrib flattened above, raised and prominent beneath; nerves 5-8 on each side, flattened and barely visible above, raised and only slightly more prominent beneath, straight in the lower half, anastomosing towards the

Fig. 3. *Triunia erythrocarpa.* Fruiting branchlet, x 1. Leaves from *B. Gray 2992* (MEL 682787); fruit from *Dansie 20104* (spirit material).

margin; reticulations lax to dense; petiole 5-8 mm long. *Inflorescence* terminal, to c. 7.5 cm long; rachis 1 mm diam., ferruginous-tomentose. *Bract* subtending flower pairs 7-10 mm long, c. 5 mm wide, acute to acuminate, rounded at the base; margin ciliate with short fine ferruginous hairs; outer surface glabrous; inner surface, dark ferruginous-velutinous; bracts covering young buds, usually caducous before anthesis, 3-4 bracts at base of inflorescence sometimes persisting for some time after other bracts have fallen. *Floral bracts* absent. *Pedicel* slender, 4-6 mm long, ferruginous-tomentose. *Flower* pleasantly perfumed, white to cream. *Perianth* zygomorphic, 1.2-2.0 cm long, anterior tepal free, 3 remaining tepals cohering at base for at least half their length; tube sparsely ferruginous-hairy; limb 2-3 mm long, becoming revolute at anthesis, densely covered with ferruginous hairs which protrude about 1 mm beyond end of limb. *Anthers* 4, 1mm long. *Hypogynous glands* posterior, 2, free, oblong, about 0.5 mm long. *Ovary* densely ferruginous-tomentose; style slender, sparsely ferruginous-hairy at base becoming glabrous towards the tip, protruding from an anterior split prior to anthesis, becoming bent at an angle to the pedicel; pollen presenter rhomboid, c. 1 mm long. *Fruit* bright red, indehiscent, globose, 1.8-3.5 cm diam., glabrous; pericarp semisucculent throughout, c. 2.5-3 mm thick; seed globose, c. 1.5 cm diam. (Fig. 3).

TYPE COLLECTION:

State Forests Reserve 310, Swipers Logging Area, 8.x.1973, *B. Hyland 6919* (flowering collection). (Holotype: QRS. Isotypes: BRI, NSW, QRS).

REPRESENTATIVE SPECIMENS EXAMINED (Total number examined 25):

*Queensland* — State Forest Reserve 310, Windin Logging Area, 15.ii.1974, *B. Hyland 7195* (QRS); Timber Reserve 165, Kobi Logging Area, 25.ix.1980, *B. Hyland 10656* (QRS); East Malanda, Atherton Tableland, 22.ix.1929, *S.F. Kajewski 1219* (BRI); State Forest Reserve 755, North Johnstone Logging Area, 3.iii.1976, *V.K. Moriarty 1961* (QRS); c. 9 miles (14.5 km) from Ravenshoe on Ravenshoe — Millaa Millaa Road, 10.x.1968, *K. Williams 205* (BRI).

DISTRIBUTION (Fig. 2):

North-eastern Queensland. Common in the Ravenshoe — Millaa Millaa — Palmerston region. There are also a number of collections from north of Mossman (Mt Spurgeon & McDowall Range) with the most northerly record being Mt Amos, about 27 km south-east of Cooktown.

ECOLOGY:

In rainforest, at altitudes from 38 m to 1000 m. Flowering September to October; fruiting February to March.

NOTES:

The specific epithet refers to the relatively large, bright red fruit which characterizes this species. The mature fruits of other *Triunia* species are smaller than those of *T. erythrocarpa* and often develop a bluish or purplish colouration at maturity.

The seeds of *T. erythrocarpa,* like those of other *Triunia* species, are apparently quite poisonous and even small quantities (about half a seed) can produce a severe reaction including decreased pulse rate, lowered blood pressure, diarrhoea and headache (Everist, 1981).

*T. montana* (C. White) D. Foreman, the only other species of *Triunia* known from north Queensland, is confined to areas of montane rainforests and differs from *T. erythrocarpa* in having mostly elliptical, coriaceous to very coriaceous leaves, shorter flowers and smaller fruits which are purplish at maturity.

Specimens now placed in *T. erythrocarpa* have been confused previously with *T. robusta* (C. White) D. Foreman (syn. *Helicia youngiana* C. Moore & F. Muell. var *robusta* C. White) a species known only from the Eumundi/Maroochie (Yandina) area of south-east Queensland. *T robusta* has fruits and flowers approaching

the proportions of those of *T. erythrocarpa* but the former species can be distinguished by its larger, coriaceous, oblong-elliptic leaves which sometimes have a few teeth towards the apex.

*T. youngiana* (C. Moore & F. Muell.) Johnson & Briggs from the rainforests of north-eastern New South Wales and south-east Queensland can readily be distinguished from *T. erythrocarpa* by its smaller fruit which matures blue to reddish, and by its acute (not acuminate) leaves which often have a sub-bullate appearance and usually have a few teeth present towards the apex.

## ACKNOWLEDGEMENTS

I would like to thank the Directors of BRI, NSW and QRS for the loan of herbarium material. I am very grateful to Dr Hj. Eichler for his advice concerning the misapplication of the name *X. salicinum*. Mr Alex George kindly prepared the Latin descriptions. I also thank Mr R.H. Barley for the illustrations.

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# THE GENUS KNIPHOFIA Moench (ALOEACEAE) IN AUSTRALIA

by

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## ABSTRACT†

Conran, J.G. The genus *Kniphofia* Moench (Aloeaceae) in Australia. *Muelleria* 6(5): 307-310 (1987). — The South African species *Kniphofia uvaria* (L.) Hook. f. is reported and described for Australia from Phillip Island in Victoria as a naturalised garden escape. This population consists of 61 mature plants that in 1985 produced an estimated 550,000 seeds with a potential germination of 82%. This large reproductive potential, coupled with large numbers of seedlings, suggests that *K. uvaria* has potential to spread to other sites.

## INTRODUCTION

*Kniphofia* Moench is included by Cronquist (1981) in the Aloeaceae, and by Dahlgren *et al.* (1985) in the Asphodelaceae subfam. Asphodeloideae. The genus is usually considered to be closely related to *Aloë* L. (Cronquist, 1981), but Baijnath (1980) and Dahlgren *et al.* (1985) argued that *Kniphofia* was sufficiently different from *Aloë* (Asphodelaceae subfam. Alooideae) to warrant its removal to the Asphodelaceae subfam. Asphodeloideae.

Forster and Clifford (1986) list three genera of the Aloeaceae *sensu* Cronquist (1981), namely *Aloë, Gasteria* Duval and *Haworthia* Duval, as naturalised in Australia or persisting in old, abandoned gardens. Subsequent to that treatment, examination of material at MEL and field observations by myself revealed a population of *Kniphofia uvaria* (L.) Hook. f., a common garden ornamental, naturalised as a garden escape in Victoria. This account is intended partly as an addendum to the treatment by Forster and Clifford (1986), and also examines the fecundity and potential for spread of this population.

Although probably better placed in the Asphodelaceae subfam. Asphodeloideae, *Kniphofia* is retained here in the Aloeaceae to conform to Cronquist's (1981) classification followed in the 'Flora of Australia'.

## TAXONOMY

*Kniphofia* is readily distinguished from other Aloeaceae in Australia by the lack of succulent leaves, the presence of a terminal inflorescence of shortly pedicellate flowers with the perianth fused for almost the entire length, and by the stamens equal to or exserted from the perianth tube. The following couplet should be added to the generic key on p. 67 of Forster and Clifford (1986):

3 Inflorescence axillary; leaves succulent, fleshy..... *Aloë*
3: Inflorescence terminal; leaves chartaceous, thin ..... *Kniphofia*

**Kniphofia** Moensch, Meth. 631 (1794); named for Johannes Hieronymus Kniphof (1704-63), Professor of Medicine, Erfurt University, Germany. TYPE: *K. uvaria* (L.) Hook.f.

*Perennial herbs* with a thick, branched rhizome (simple in some extra-Australian species), and fleshy, fibrous roots. *Leaves* simple, alternate, sessile, in dense rosettes,

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† Since this manuscript went to press a healthy colony of *K. uvaria* has been located and voucher specimens collected from New South Wales, 8 km south of Berrima on the Hume Highway, 34° 31′ S., 150° 18′ E., 29.xii.1986, *J.G. Conran* (MEL, NSW). The colony consisted of about ten flowering clumps, plus seedlings, in roadside verge.

linear, chartaceous; margins entire (fine toothed in some extra-Australian species). *Inflorescence* a simple, terminal, condensed to long-cylindrical, sub-spicate raceme. *Flowers* zygomorphic, pedicellate, pendulous to spreading, protandrous. *Tepals* connate into a tube; apices shortly free, subequal, obtuse, spreading. *Stamens* exserted or equalling perianth tube. *Style* filiform, subequal to stamens at anthesis, later exserted; ovary 3-locular; ovules axile, in two rows per loculus. *Fruit* a loculicidal capsule. *Seeds* numerous, irregularly triquetrous to flattened, dark brown.

An African, Madagascan and Arabian genus of c. 70 species; in Australia, a single introduced species naturalised in Victoria.

**Kniphofia uvaria** (L.) Hook.f. Bot. Mag. t. 4816 (1854). — *Aloë uvaria* L. Sp. Pl. 1: 323 (1753). TYPE: Specimen in Herb. Hort. Cliff. (BM *n.v.*, *fide* Codd (1968)).

Stemless herb to c. 1.5m tall with thick branched rhizome. *Leaves* linear, tapering, acute, with a prominent, keeled, scabrid midrib, 35-80 cm long, 0.5-2 cm wide; sessile. *Inflorescence* a dense, pedunculate, subspicate raceme, 7-11 cm long, with numerous flowers, elongating to c. 30 cm in fruit; peduncle 60-120 cm long; pedicels 2-5 mm long, elongating to c. 8 mm in fruit. *Perianth* orange-red to yellow-green in bud, turning paler at anthesis, 35-40 mm long, 5-6 mm wide; apical 2 mm free, spreading. *Stamens* 40-45 mm long; anthers 2 mm long, yellow, turning black. *Ovary* glabrous, ovoid, 4-5 mm long; style single, filiform, minutely capitate, 40-45 mm long, exserted after anthesis and exceeding stamens. *Capsule* elongate-ovoid, trigonal, 7-14 mm long. *Seeds* numerous, 3 mm long. Red Hot Poker.

Chromosome Number: 2n = 12 *fide* Fedorov (1969).

Native to southern Africa; naturalised in Australia only at one Victorian locality (see Specimens Examined).

SPECIMENS EXAMINED:

*Victoria* — Flynn Reef, Phillip Island, 38° 30'S., 145° 09'E., 5. vii. 1984, *D.E. Albrecht 572* (MEL 673996); Flynn Reef, Phillip Island, 38° 30'S., 145° 09'E., 17. v. 1986, *J.G. Conran 373* (MUCV).

## FECUNDITY AND POTENTIAL FOR SPREAD

### Materials and Methods

Plants of *K. uvaria* growing at Flynn Reef, Phillip Island, (30° 30'S., 145° 09'E.) were measured in the field. The total number of mature (fruiting or flowering) plants at the colony was recorded. To determine the potential and realised fecundity of individuals for 1985-6, the average numbers of mature shoots and inflorescences per plant from the 1986 flowering season were determined from a sample of 30 plants. Ten infructescences produced during the 1985 flowering season were collected, and the number of fruits and flower scars counted to determine the total flower and fruit numbers. To determine potential and actual seed set, ten flowers and 10 unopened capsules from the 1986 season were also collected, and the numbers of ovules and seeds respectively, recorded. These data were all converted to averages, and estimates of potential fecundity (PF) and actual fecundity (SF) seed set per plant were calculated using the following formulae:

$$PF = I/P \times F/I \times O/F$$
$$SF = I/P \times C/I \times S/C$$

where I/P = av. no. of inflorescences per plant; F/I = av. no. of flowers per inflorescence; O/F = av. no. of ovules per flower; C/I = av. no. of capsules per inflorescence; S/C = av. no. of seeds per capsule. Percentage fertility was then estimated from the PF and SF. Seed from ten plants was collected, and 100 seeds of each were planted on moist filter paper in petri dishes under c. 3500 lux (8 hours day length) at c. 20°C to determine percentage germination.

**Results**

The population contained 61 mature plants. Results of the fecundity study show that the plants have fruit sets of 90% and seed sets of 25%, with the colony producing an estimated 550,000 seeds for the 1985-6 season, with 82.1% germination at 14 days, after which no further germination was seen to occur (Table 1).

Table 1. Data for fecundity and seed germination in *Kniphofia uvaria* at Flynn Reef, Phillip Island.

| Attribute | Mean (±SD) | Sample Size |
|---|---|---|
| Sh/P (Shoots per plant) | 8.4 (±7.1) | 30 |
| I/P (Inforescences per plant) | 3.1 (±3.4) | 30 |
| F/1 (Flowers per inflorescence) | 254.3 (±75.2) | 10 |
| C/1 (Capsules per inflorescence) | 230.9 (±74.2) | 10 |
| % Fruit Set | 90.0 (±4.2) | 10 |
| O/F (Ovules per flower) | 45.1 (±7.3) | 10 |
| S/C (Seeds per capsule) | 12.6 (±3.8) | 10 |
| PF/P (Est. potential fecundity per plant) | 36,000 | — |
| SF/P (Est. actual fecundity per plant) | 9,000 | — |
| Estimated % SF | 25.0 | — |
| Total SF estimated for population | 550,000 | — |
| % Seed germination | 82.1 (±15.0) | 1,000 |
| Estimated potential seedlings per annum | 450,000 | — |

## DISCUSSION

Apparently naturalised plants, agreeing with the description of *K. uvaria sensu* Codd (1968) had, until recently, been observed at two locations in Victoria, namely the Flynn Reef site, and on the Bellarine Peninsula, 6 kilometres north of Ocean Grove (38° 16'S., 144° 31'E). At the latter location, a single plant of about 6 shoots was observed flowering in December 1985, but was subsequently destroyed by land development before a collection could be made.

The colony at Flynn Reef occupies an area of about 500 $m^2$ (50 x 10 m) of back dune swale, growing with *Isolepis nodosa* (Rottb.) R. Br and *Paspalum dilatatum* Poir. All of the plants bore evidence of both flowering and heavy fruit set, and the flowers produce copious quantities of nectar. Syrphid flies, Ichneumonid wasps and ants (*Iridomyrmex* sp.) were observed to visit the flowers. Visiting ants were covered in *Kniphofia* pollen, but the form of the inflorescences and flowers of *K. uvaria* suggest birds as the likely pollinators (Pijl, 1982). The levels of both fruit and seed set indicate that either efficient animal pollination or else self pollination is occurring. The fecundity of the colony is reflected in the large numbers of seedlings and immature plants (15-20 per $m^2$) which occur on bare ground close to mature plants.

Codd (1968) lists two main flowering periods, October-December and April-May, for *K. uvaria* in South Africa, with occasional plants flowering at almost any time of the year. Flowering in the African *Kniphofia* spp. is apparently enhanced by fire (Codd, 1968). The population at Phillip Island flowers from at least May to September, with the main flowering period apparently from July to August. Codd (1968) mentions that many cultivated *Kniphofia* plants were of hybrid origins, and this may possibly explain the difference in flowering peaks, although most *Kniphofia* species are dormant during June-July. The plants grow in a back dune swale which is probably similar to the moist sites which are the natural habitat of *Kniphofia* in South Africa (Codd, 1968).

While *Kniphofia uvaria* is not usually regarded as a serious (or even potential) pest species, the Flynn Reef population occurs partly within a State Conservation Area and Penguin Fauna Reserve. It would be advisable, given the high reproductive potential of the population (an estimated 450,000 seedlings per annum) for the local management authorities to monitor the population in case the plants spread further into the dune swales, to the possible detriment of the native vegetation.

## ACKNOWLEDGEMENTS

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# LIMNOPHYTON AUSTRALIENSE sp. nov. (ALISMATACEAE): A NEW GENERIC RECORD FOR AUSTRALIA

by

HELEN I. ASTON*

## ABSTRACT

Aston, Helen I. *Limnophyton australiense* sp. nov. (Alismataceae): a new generic record for Australia. *Muelleria* 6(5): 311-316 (1987). — A new species of *Limnophyton* Miq., *L. australiense,* from Cape York Peninsula, Queensland, is described and illustrated and the characteristics and affinities of the genus are discussed. This is the first record of *Limnophyton* from Australia.

## DESCRIPTION

**Limnophyton australiense** H. I. Aston, sp. nov.

*Planta* aquatica, emergens, erecta, glabra. *Folia* basalia, longe petiolata. *Lamina folii* sagittata, 5-21 cm longa x 2.8-14 cm lata; lobo apici quam lobis basalibus parum longiore. *Caules* ad 100 cm alti x 2-10 mm diametro, simplices vel bifurcati (ad nodum infimum). *Verticilli inflorescentiae* 3-8 per caulem vel ramum caulis, quoque verticillo 3 bracteis praedito; verticillus infimus polygamus, usque ad 10 flores masculinos et 13 flores bisexuales ferens; verticilli alii solum masculini 9-12-flori. *Flores masculini* in pedicellis filiformibus (c. 9-14 mm longis x 0.15-0.5 mm diametro); sepala 3, concava, reflexa, c. 4.2-5 mm longa x 3.3-3.5 mm lata; petala 3, c. 6-6.3 mm longa x 3.7-4.4 mm lata; stamina 6 in verticillo uno regulari; filamenta c. 2 mm longa, tribus-quadrantibus inferioribus c. 1.1 mm latis, dialatatis, bulbosis; filamentorum bases tumidae, arcte appressae ad centrum floris; carpella absentia. *Flores bisexuales* ut in floribus masculinis sed carpellati atque pedicellis majoribus instructi; pedicelli fructiferi 25-60 mm longi x 1.5-3.5 mm diametro; receptaculum minutum, plus minusve planum vel perexigue elevatum; carpella 3-16, libera sessilia; ovarium c. 2 mm longum, porcula dorsali atque umbone in quoque latere munitum; stylus brevis crassus; stigma c. 0.4 mm longum x 1.4 mm latum, discoideum, cacumen styli cingens; ovulum singulare, basale, campylotropum. *Carpella fructificantia* 5-15, sessilia vel subsessilia, sicca, indehiscentia, endocarpium tenue, sclerenchymatum; exocarpium tenue, spongiosum. *Corpus carpelli fructificantis* plus minusve late oblongum vel late obovoideum, lateraliter compressum, sine cavernulis-aeriis lateralibus magnis, c. 10-12 mm longum x 3.5-4 mm latum x 6.5-8 mm profundum (i.e. a margine dorsali usque ad marginem ventralem), porcatum, spinescens; porcae 3, una margines ventrales apicales et dorsales cingenti, quaque duarum aliarum depressionem lateralem plus minusve ellipticam non profundam cingenti; spinae porcas exorientes, 2-5 conspicuae pungentes 3-5 mm longae, porcis etiam spinas breviores (1-paucas) vel torulas usitate ferentibus. *Semen* perlate ellipsoideum, fortiter lateraliter compressum, c. 7 mm longum; embryo hippocrepicus.

*Limnophyton australiense* ob carpella fructificantia magna spinescentia facile distinguitur; forma carpellorum a speciebus omnibus aliis generis *Limnophyti* differt, praeterea cavernulae-aeriae laterales magnae desunt.

*Plant* aquatic, emergent, ? annual or perennial, glabrous. *Roots* fibrous, from a short rootstock to 1.5 cm long. *Stems* 2, basal, erect, to 100 cm high x 2-10 mm diam., simple or divided into two more or less equal branches at the lowest node; height from base to lowest node 46-71 cm; distal 19-29 cm of stem (or each branch) bearing 3-8 whorls of flowers, the internodes 1-8 cm long and somewhat longitudinally ribbed. *Leaves* several, basal, petiolate, erect. *Petiole* 40-81 cm long x 2-10 mm diam., sheathed at the base, (producing a milky exudate when broken, *Hyland 6296*); sheath 23-42 cm long, gradually tapered above. *Leaf lamina* thin-textured, membranous, sagittate, slightly to strongly constricted just above the level of insertion of the petiole, 5-21 cm long x 2.8-14 cm wide, with the greatest width usually across the proximal to mid-portions of the basal lobes; apical lobe slightly longer than the basal lobes, 2.8-11 cm long x 2.2-12 cm wide; basal lobes somewhat incurved with a sinus of (40°-)55°-75° angle (the angle formed at the petiole insertion by lines connecting that point to the tips of the basal lobes), each 2.3-10 cm long

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x 0.9-5.5 cm wide; main lamina nerves conspicuous, c. 11-20, more or less longitudinal-curvinerved, radiating from the point of petiole attachment along the apical and basal lobes; crossnerves more or less inconspicuous, (1-)1.5-4 mm apart, at 60°-80° angle to the main nerves. *Inflorescence whorls* 3-8 per stem or stem-branch, the lowest 1(-2) whorls polygamous, the remaining whorls male only. *Polygamous whorl* with 3 bracts and up to 10 male and 13 bisexual flowers; bracts membranous, lanceolate, acute, c. 30 mm long x 9 mm wide, with c. 9 main and many finer longitudinal nerves; each bract subtending 1-4 male and 1-5 bisexual flowers. *Male whorls* with 3 bracts and 9-12 male flowers; bracts similar to those of the polygamous whorl but smaller, to c. 20 mm long x 9.5 mm wide, each bract subtending 3-4 male flowers. *Male flowers* on filamentous pedicels c. 9-14 mm long x 0.4-0.5 mm diam. in the polygamous whorl, only 0.15-0.25 mm diam. in male whorls; sepals 3, more or less round or broadly ovate, very concave to almost hooded, c. 4.2-5 mm long x 3.3-3.5 mm wide, reflexed; petals 3, alternate with the sepals, broadly ovate to lanceolate-oblong, obtuse, contracted at the base, c. 6-6.3 mm long x 3.7-4.4 mm wide, more or less upcurved to spreading; stamens 6, in one regular whorl, 2 opposite each sepal; filaments c. 2 mm long, slender above, the lower three-quarters dilated into a conspicuous, bulbous, more or less papillose-surfaced base c. 1.1 mm wide; swollen filament bases tightly appressed at the flower centre, forming a 6-partite filament mass ± 3 mm diam.; anther broadly ovate to broadly obloid, dorso-ventrally compressed, c. 1.5-1.7 mm long x c. 1.2-1.4 mm wide x c. 0.5-0.6 mm deep, 2-loculed with broad connective tissue between the locules, basally attached, dehiscing laterally, maroon-brown; carpels absent. *Bisexual flowers* as for the male flowers but larger pedicelled and carpellate; pedicles 25-60 mm long x 1.5-3.5 mm diam. when in fruit; receptacle minute, very slightly raised, more or less flat; carpels irregularly centrally placed on the receptacle, the stamens being separated and peripheral; carpels 3-16, free, sessile, c. 3 mm long; ovary c. 2 mm long, somewhat laterally compressed, with a dorsal ridge and with a large lateral boss on each side, the ridge bearing 1-4 low blunt points and each boss bearing from its edges 1-3 similar points; style short and thick, c. 0.6 mm long, placed apically at the ventral edge of the ovary, persistent; stigma c. 0.4 mm long x c. 1.4 mm wide, an undulate, slightly crenate to lobed, more or less horizontal flange encircling the style summit, narrowed and slit on the ventral edge, densely papillate with minute papillae; ovule 1, basal, compressed-ellipsoid, campylotropous. *Fruiting carpels* 5-15, sessile or sub-sessile on short thick gynophores to c. 3 mm long, dry, indehiscent, with thin schlerenchymatous endocarp and thin spongy exocarp; body of fruiting carpel more or less broadly oblong or broadly obovoid, laterally compressed, without large lateral air chambers, c. 10-13 mm long (including gynophore) x 3.5-4 mm wide x 6.5-8 mm deep (= dorsal to ventral edge), ornamented with thin low ridges and with 2-5 conspicuous pungent spines 3-5 mm long, usually also 1-few smaller spines or low projections; ridges 3, one encircling the ventral apical and dorsal edges, the other two encircling two shallow and more or less elliptical depressions sited one on each lateral face; spines and projections positioned on the ridges. *Seed* 1, basal, very broadly ellipsoid, strongly laterally compressed, c. 7 mm long x 2.5 mm wide x 5-6 mm deep; embryo horseshoe shaped.

TYPE COLLECTION:

38 km from Wakooka on the track to Bathurst Bay and Cape Melville National Park, 14° 1-′ S., 144° 2-′ E., Cook district, Queensland, 19.vi.1984, *J. R. Clarkson 5434* (Holotype: BRI. Isotypes: BRI (one large leaf), K, MEL 1545207, QRS; also spirit collections BRI, MEL 1265/B).

OTHER SPECIMENS EXAMINED:

*Queensland (Cape York Peninsula)* — Bathurst Bay (Muck River), 14° 15′ S., 144° 25′ E., 27.vii.1972, *B. Hyland 6296* (QRS 042718 and 042719); "Lakefield", c. 12 km NNW. of "Breeza Plains" outstation, c. 14° 44′ S., 144° 05′ E., 10. viii. 1978, *A. Kanis 1962* (BRI 293616; CANB 326124; also L *n.v.*); 30 km N. of "Kalpowar" homestead, 14° 34′S., 144° 10′ E., 13.viii.1978, *K. Paijmans 2887* (CANB 286881-883).

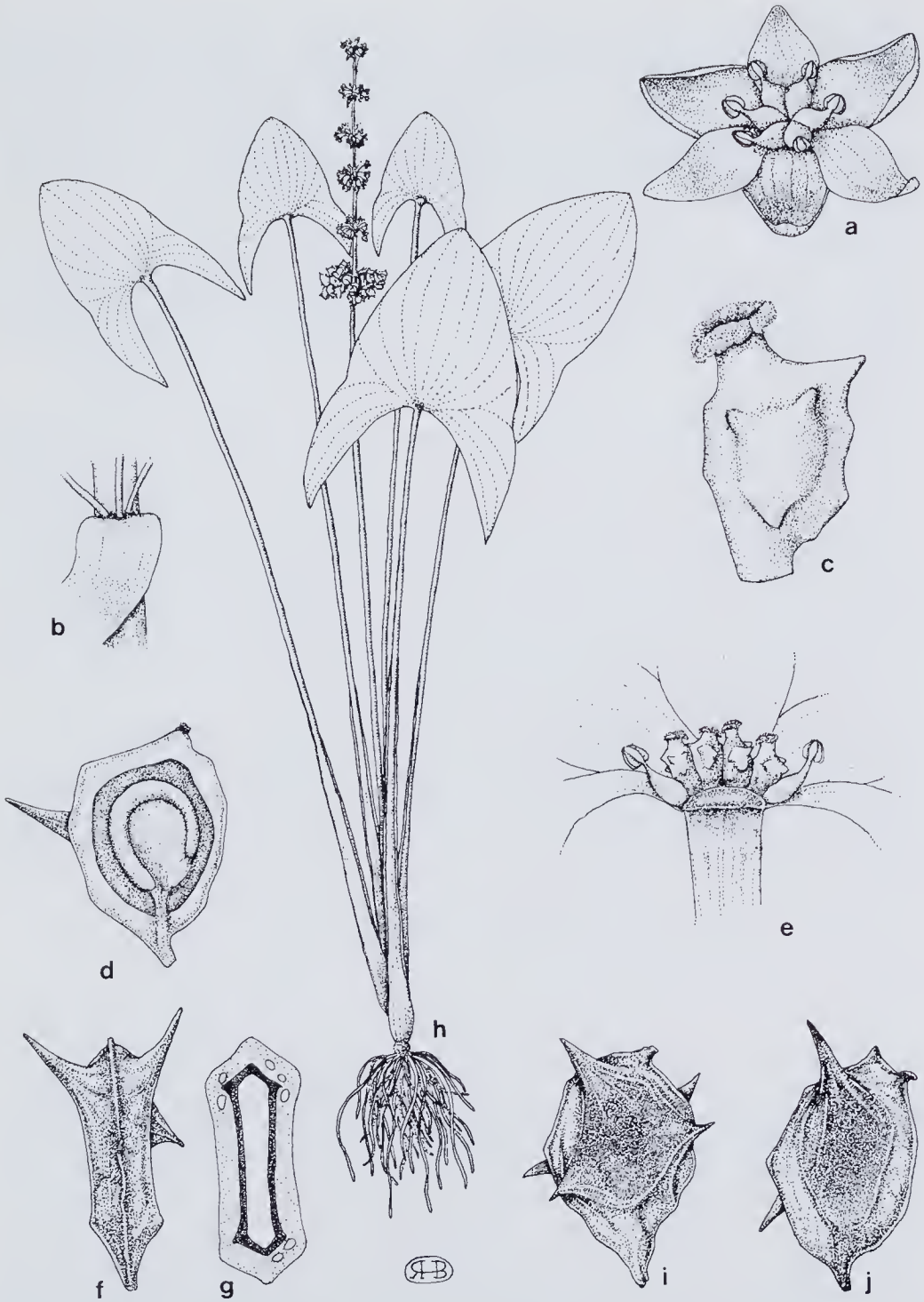


Fig. 1. *Limnophyton australiense*. a — male flower, x 3. b — portion of male whorl, showing three pedicels arising from the axil of one of the bracts, x 3. c — carpel from bisexual flower, x 15. d — fruiting carpel, L.S. showing the solitary seed with curved embryo; carpel cavity darkly stippled, x 3. e — bisexual flower, L.S. showing the slightly raised receptacle, x 4. f — fruiting carpel, dorsal view, x 3. g — fruiting carpel, T.S. showing the sclerenchymatous endocarp (dark) and very small air cavities within the spongy exocarp; seed removed, x 4. h — habit, x 0.2. i — and j — fruiting carpels, lateral views showing varied development of spines, x 3. All from *Clarkson 5434*.

DISTRIBUTION:

*Queensland (Cape York Peninsula)* — In the Bathurst Bay and Lakefield regions. Known only from the four collections cited above and from 11 km NNW. of the crossing of the Kennedy River between "Laura" and "Lakefield" homesteads, c. 14° 59′ S., 144° 15′ E., Lakefield National Park, located by S. Trezise, 15.v.1982. There is no preserved collection from the Lakefield site but I have seen one large typical leaf from there and consider this unmistakeable compared with that of any other naturally occurring species in Australia.

HABITAT:

Forms dense stands in shallow fresh water of lagoons and waterholes in lowland areas. Water depth of 30 cm and altitudes of 5 and 50 metres recorded. ". . . waterhole in *Eucalyptus polycarpa* woodland" (*Clarkson 5434*). "Shallow billabong surrounded by *Melaleuca*" (*Kanis 1962*). ". . . shallow water with muddy bottom" (*Hyland 6296*).

NOTES:

*Limnophyton australiense* is distinguished by its large spinescent fruiting carpels. These are shaped unlike those of any other species of *Limnophyton* and lack large lateral air chambers.

Large lateral air chambers are conspicuous in the fruiting carpels of the type species, *Limnophyton obtusifolium* (L.) Miq., and are usually regarded as a generic character. To determine if such chambers were actually present in *L. australiense* but had deflated upon drying two fruiting carpels were boiled in water for softening and expansion. Sectioning of the boiled carpels showed that they more or less retained their dried shapes and that the only air chambers were minute and discontinuous, occurring irregularly throughout the exocarp in the vicinity of the lateral ridges, particular near the spine bases.

The depression and encircling ridge present on each side of the fruiting carpel are developed from the lateral boss of the immature carpel.

*Clarkson 5434* records flowers [? = sepals and petals] yellow, bracts reddish. *Kanis 1962* records tepals green.

Measurements of vegetative parts and fruiting carpels have been taken from dried specimens, whereas floral measurements and most descriptions of floral parts have been made from spirit material.

The epithet *australiense* is bestowed because this species is the only one of its genus known from Australia, where apparently it is endemic.

## CHARACTERISTICS AND AFFINITIES OF LIMNOPHYTON

*Limnophyton* Miq., Fl. Ned. Ind. 3:242 (1856, *non* 1855), is found in tropical Africa, Madagascar, India, Ceylon, Vietnam, Java, Timor (Hartog, 1957) and, from the current recording, in north-east Australia. Apart from *L. australiense,* three other species are recognised in the genus, all of which are treated in detail by Symoens (1984).

Pichon (1946) accepted 15 genera within the tribe Alismateae, his equivalent of the family Alismataceae as generally circumscribed today. More recent authors such as Hutchinson (1973), Cook *et al.* (1974) and Cook (1978) accept only 11 to 13 genera within the family, with Cook commenting that "generic delimitation in the Alismataceae is somewhat unsatisfactory". *Limnophyton,* however, is readily distinguished from all other genera except *Sagittaria* L. (including *Lophotocarpus* T. Durand) by its polygamy. In other characters *Sagittaria* is quite distinct, having numerous carpels arranged spirally on a large globular to oblong receptacle, the number of stamens indefinite (7-numerous) and the flowers chiefly unisexual with the upper male and the lower female or occasionally bisexual.

Hartog (1957), Symoens & Billiet (1975), Symoens (1984) and Carter (1960) give detailed treatments of *Limnophyton* from Malesia, Africa, Africa and Africa respectively. The first three papers and Cook *et al.* (1974) give the presence of large lateral air chambers in the fruiting carpels as one of the main characters segregating *Limnophyton* from *Caldesia* Parl., which lacks air chambers. Hutchinson (1973) ignored this character. As the newly described species lacks large carpel air chambers (see notes above under description) it seems that their presence or absence is significant only at specific, rather then generic, level. In other characters the new species is readily placed in *Limnophyton*. Although *Caldesia* is still somewhat poorly defined and in some cases shows "extreme intrageneric variation" (Lai, 1977) or is "somewhat artificially segregated" (Cook, 1978) its tendencies lie toward the bisexual-flowered, large-receptacled, 9-many stamened, New World genus *Echinodorus* Engelm. and its allies (Cook *et al.*, 1974) rather than toward the Old World genus *Limnophyton*.

*Caldesia* occurs in northern and north-eastern Australia (Aston, 1973) as well as in Europe, Africa, Madagascar, south and east Asia, Malaysia and New Guinea (Hartog, 1957; Symoens, 1984; Leach and Osborne, 1985). Its major similarities with and distinctions from *Limnophyton* are shown in the following key:

Leaves basal; receptacle small, more or less flattened; carpels 2-20, free, crowded, not spiralled or whorled; ovules 1 per carpel; fruiting carpels dry and indehiscent ..... 1

1. Inflorescence usually simple, with flowers in whorls of more than three; flowers polygamous; stamens 6; filaments prominently dilated at the base; style thickish with expanded flanged apical stigma; fruiting carpels with or without large lateral air chambers ..... *Limnophyton*

1. Inflorescence usually a compound pyramidal panicle, the branches and flowers usually in whorls of three; flowers bisexual; stamens 6(-12); filaments filiform or flattened, not dilated; style slender, distally stigmatic, not expanded; fruiting carpels without large lateral air chambers ..... *Caldesia*

Additionally, for the species found in Australia, the leaf laminas of *Limnophyton* are sagittate whereas those of *Caldesia* are cordate, or more or less cordate but with the basal lobes obtusely to acutely pointed. This distinction also applies to extra-Australian species except *Limnophyton fluitans* Graebner with linear-lanceolate laminas (Symoens, 1984) and *Caldesia grandis* Samuelsson with the lamina base either cordate or broadly obtuse to truncate (Lai, 1977).

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My gratitude is extended to Mr S. Trezise of Laura, Queensland, whose 1982 discovery of the Lakefield population first alerted me to the presence of some unknown alismataceous species in the area; to Mr J.R. Clarkson, Mareeba branch of the Queensland Herbarium, whose dried and spirit material from the type population enabled the species to be adequately described; to the Queensland Herbarium, Brisbane, the Australian National Herbarium, Canberra, and Mr B.P.M. Hyland of C.S.I.R.O. Forest Research Institute, Atherton, Queensland, for the loan of or access to additional collections; to Dr J.H. Willis, Brighton, Victoria, for preparation of the Latin description from an English draft; to Mr R.H. Barley, National Herbarium of Victoria, for providing the illustration.

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Symoens, J. J. and Billiet, F. (1975). Alismataceae. In *Fl. D'Afrique Centrale* 1975: 1-21. [Includes full illustrations of *Limnophyton angolense* and *Caldesia reniformis*.]

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# NOTES ON GNEPHOSIS Cass. (COMPOSITAE: INULEAE: GNAPHALIINAE)

by

P. S. SHORT*

## ABSTRACT

Short, P. S. Notes on *Gnephosis* (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6(5): 317-319 (1987). — The name *Chrysocoryne* Endl. is reduced to the synonymy of *Gnephosis* Cass. New combinations are made in *Gnephosis* and a lectotype for the name *G. tenuissima* Cass. is chosen.

## INTRODUCTION

In my revision of *Angianthus* Wendl. s. lat. (Short 1983) I reinstated certain genera previously reduced to synonymy by Bentham (1867). One of these, *Chrysocoryne* Endl., described in 1843, I considered to consist of six species. Since that revision I have examined the genus *Gnephosis* Cass., described with a single species, *G. tenuissima* Cass., in 1820, and it is now clear that *Chrysocoryne pusilla* (Benth.) Endl. is synonymous with *G. tenuissima.* Since the name *Gnephosis* has priority over the name *Chrysocoryne,* five of the species currently placed in *Chrysocoryne* need to be transferred to *Gnephosis.* The new combinations are made below and a lectotype for *G. tenuissima* is chosen.

Although my revisionary studies are incomplete it seems likely that *Gnephosis s. str.* will only include *G. tenuissima* and the five species here transferred from *Chrysocoryne.*

## NEW COMBINATIONS AND SYNONYMS IN GNEPHOSIS

Except for *G. tenuissima,* detailed comments on the types of all names given here are to be found in a previous publication (Short 1983).

**Gnephosis** Cass., Bull. Sci. Soc. Philom. Paris 43 (1820). TYPE: *G. tenuissima* Cass.

*Chrysocoryne* Endl., Bot. Zeitung (Berlin) 1:457 (1843); P. Short, Muelleria 5: 185 (1983). TYPE: *C. drummondii* A. Gray.

**Gnephosis drummondii** (A. Gray) P. Short, *comb. nov.*

*Chrysocoryne drummondii* A. Gray, Hook, J. Bot. Kew Gard. Misc. 3:152 (1851), basionym. LECTOTYPE: *Drummond 16* (K).

*Chrysocoryne tenella* F. Muell., Trans. & Proc. Vict. Inst. Advancem. Sci. 130 (1855). — *Angianthus tenellus* (F. Muell.) Benth., Fl. Austr. 3:564 (1867). — *Styloncerus tenellus* (F. Muell.) Kuntze, Rev. Generum Pl. 367 (1891). — *Siloxerus tenellus* (F. Muell.) Ostenf., Biol. Meddel. Kongel. Danske Vidensk. Selsk. 3:138 (1921). LECTOTYPE: *Wilhelmi* (K).

**Gnephosis multiflora** (P. Short) P. Short, *comb. nov.*

*Chrysocoryne multiflora* P. Short, Muelleria 5:192 (1983), basionym. HOLOTYPE: *Chinnock 4411 & Wilson* (AD).

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**Gnephosis tenuissima** Cass., Bull. Sci. Soc. Philom. Paris 43 (1820). LECTOTYPE (here chosen — see separate discussion below): *Anon. s.n.*, "Nouv hollande, Port jackson", s. dat. (P, annotated by Cassini); ISOLECTOTYPE: *Anon. s.n.* "port jackson", s. dat. (P, ex herb. Poiret, ex herb. Moquin-Tandon, ex herb. Cosson); POSSIBLE ISOLECTOTYPES OR POSSIBLE REMAINING SYNTYPES: *Anon s.n.*, "Habitat in novaehollandia", s. dat. (P); *Anon. s.n.*, no locality, s. dat. (P, annotated by Cassini); REMAINING SYNTYPE: *Anon. s.n.*, "Baie des chiens marins, Voyage du capitaine Baudin 1801, Nouv Hollande", s. dat. (P).

*Crossolepis pusilla* Benth. in Endl. Enum. Pl. 61 (1837). — *Chrysocoryne pusilla* (Benth.) Endl., Bot. Zeitung (Berlin) 1:458 (1843). — *Chrysocoryne huegelii* A. Gray, Hook. J. Bot. Kew Gard. Misc. 3:151 (1851), *nom. illeg.* — *Angianthus pusillus* (Benth.) Benth., Fl. Austr. 3:564 (1867). — *Styloncerus pusillus* (Benth.) Kuntze, Rev. Generum Pl. 367 (1891). — *Siloxerus pusillus* (Benth.) Ising, Trans & Proc. Roy. Soc. S. Aust. 46:604 (1922). LECTOTYPE: *Hügel* (W).

[*Podolepis divaricata* A. Cunn. ex DC., Prod. 6:151 (1838), *nom. in sched.*]

**Gnephosis tridens** (P. Short) P. Short, *comb. nov.*

*Chrysocoryne tridens* P. Short, Muelleria 5:199 (1983), basionym. HOLOTYPE: *Short 1041* (AD).

**Gnephosis trifida** (P. Short) P. Short, *comb. nov.*

*Chrysocoryne trifida* P. Short, Muelleria 5:196 (1983), basionym. HOLOTYPE: *Short 966* (AD).

**Gnephosis uniflora** (Turcz.) P. Short, *comb. nov.*

*Chrysocoryne uniflora* Turcz, Bull. Soc. Naturalistes Moscou 24(1):188 (1851), basionym. HOLOTYPE: *Drummond 116* (KW).

*Chrysocoryne myosuroides* A. Gray, Hook. J. Bot. Kew Gard. Misc. 3:152 (1851). — *Angianthus myosuroides* (A. Gray) Benth., Fl. Austr. 3:563 (1867). — *Styloncerus myosuroides* (A. Gray) Kuntze, Rev. Generum Pl. 367 (1891). LECTOTYPE: *Drummond 116* (K).

## LECTOTYPIFICATION OF G. TENUISSIMA CASS.

In his original publication of *G. tenuissima* Cassini (1820) noted that he had examined plants from Port Jackson and Shark Bay ('Baie des Chiens-Marins'). Five sheets, considered to be syntypes or possible syntypes, have been located in the Natural History Museum in Paris (P). The labels accompanying the sheets generally provide little information about the collections (see above). One of the sheets, annotated by Cassini and said to be from Port Jackson, has been selected as the lectotype of the name *G. tenuissima*. It consists of about nine individual plants.

All syntype material examined by Cassini appears to have been collected on the Baudin expedition (1800-1804) to Australia. However, although the expedition called at both Port Jackson and Shark Bay the reference to Port Jackson as a locality of *G. tenuissima* seems erroneous. The species is widespread across much of Australia but is only found west of the Great Dividing Range. It therefore seems more likely that all material examined by Cassini came from Shark Bay, where the species is common. All syntypes or possible syntypes strongly resemble modern collections from that region (*G. tenuissima* is polymorphic), and vessels from the Baudin expedition visited Shark Bay in 1801 and 1803 (Marchant 1982).

The two collections referred to above as possible isolectotypes or possible remaining syntypes may not be types despite the fact that one is annotated by Cassini. In P there are several collections of *G. tenuissima* made by Gaudichaud,

a member of Freycinet's expedition (1817-1820) to Australia. At least some of these collections come from Shark Bay. However, none of them can be type material of *G. tenuissima* as the expedition returned to France in November 1820 (Marchant l.c.) and Cassini had already published the name in March of that year. He subsequently may have annotated specimens collected on the Freycinet expedition, hence I am not certain that the annotated specimen is part of the type material.

Because the Port Jackson locality on the lectotype sheet is probably erroneous it seems that a further Port Jackson collection in P must be an isolectotype. The mistake in locality is unlikely to have been repeated for any collections made on the Freycinet expedition.

The remaining syntype cited above is the only collection marked as coming from "Baie des chiens marins" on the Baudin expedition. Although probably coming from the same locality as the lectotype I consider it to be a separate gathering. As it is the only collection from the Baudin expedition actually labelled as coming from Shark Bay I should possibly have selected it as the lectotype. However this sheet is not annotated by Cassini and I believe it more prudent to select the lectotype from material clearly annotated by the author.

## ACKNOWLEDGEMENTS

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# TWO NEW SPECIES OF WESTRINGIA (LABIATAE) FROM NEW SOUTH WALES

by

BARRY J. CONN*

## ABSTRACT

Conn, B.J. Two new species of *Westringia* (Labiatae) from New South Wales. *Muelleria* 6(5): 321-328 (1987). — *Westringia davidii* and *W. saxatilis*, both from south-eastern New South Wales, are described for the first time.

## INTRODUCTION

The two new species of *Westringia* which are described herein are rare and possibly vulnerable. At least one of them is not included in a conservation reserve. The publication of these species will enable them to be formally recognized by the management authorities concerned with these areas. It is hoped that this recognition will result in appropriate management procedures being implemented which will protect these rare species.

Terminology and presentation follows that used in Conn (1984, pp. 211-220).

## TAXONOMY

**Westringia davidii** Conn, sp. nov.

Frutices 0.5-1 m. alti. *Rami* et ramuli subteretes, dense tomentosi. *Folia* verticillata terna, tomentosa usque glabrescentia; *petiolus* 1-2 mm. longus; *lamina* ovata usque obovata, 7-20 mm. longa, 5-8 mm. lata, basi cuneata, margine integro et recurvo, apice breviter mucronato. *Pedicellus floris* 1.3-2 mm. longus, dense tomentosus, *prophyllis* lineari-ovatis usque lineari-obovatis, 4-5.5 mm. longis, 0.3-0.5 mm. latis, dense tomentosis. *Calyx* ex parte viridis, lobi margine purpurpeo vel calyx ubique purpurascens, extra dense tomentosus; *tubus* 2-3.3 mm. longus, intra glaber; *lobi* anguste deltoidei, 2.5-4.8 mm. longi, 0.8-1 mm. lati, intra moderate usque dense tomentosi, apice angustato. *Corolla* 8-12 mm. longa, pallido-malvina, extra in partibus distalibus sparsim usque dense tomentosa, intra in partibus basaliter moderate tomentosa et in partibus distalibus sparsim tomentosa; *tubus* circa 8 mm. longus; *lobus abaxiali-medianus* spathulatus, 5.6-7 mm. longus, 7-8 mm. latus; *lobi laterales* oblongi usque subobovati, 4.8-6 mm. longi, 3.4-3.9 mm. lati; *par loborum adaxiali-medianum* latissime oblongum, 5.2-6 mm. longum, circa 6 mm. latum. *Androecium* ore corollae insertum; filamenta staminum 1.7-2 mm. longa; antherae 1-1.5 mm. longae; filamenta staminodiorum 2.9-3.3 mm. longa, tomentosa; lobi staminodiorum 0.6-1 mm. longi. *Pistillum* 7-8 mm. longum; ovarium circa 0.6 mm. longum; stylus circa 6-6.6 mm. longus, tomentosus; stigma usque ad circa 0.3 mm. longum. *Mericarpia* 1.8-2 mm. longa.

TYPE: *Albrecht 2413*, 21.i.1986, 1.7 km N. of the intersection of the Sugarloaf Fire Road and the Back Creek Fire Road, Nullica State Forest, New South Wales (Holo.: MEL 1546995; iso.: NSW).

Shrub, 0.5-2 m high. *Branches* subterete; internodes with raised ridges from axil of leaf to next more distal node, densely hairy [c. 150-200 hairs/mm$^2$], hairs simple, ± straight, subpatent to subappressed, antrorse, 0.3-0.7 mm long, white. *Leaves* in whorls of 3, spreading, abaxial surface and petiole densely hairy [100-120 hairs/mm$^2$] with ± patent, slightly tangled hairs, adaxial surface very sparsely hairy [up to c. 20 hairs/mm$^2$], glabrescent distally; *petiole* 1-2 mm long; *lamina* ovate to obovate, 7-20 mm long, 5-8 mm wide [lamina length to width ratio 1.4-2.6, length of maximum width from base to total lamina length ratio 0.4-0.7], base cuneate, margin entire and recurved, apex shortly mucronate (mucro c. 0.3 mm

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long); venation not visible, midrib raised on abaxial surface. *Inflorescence* a frondose racemiform conflorescence, uniflorescence monadic, up to c. 12-flowered [per conflorescence]. *Pedicel* 1.3-2 mm long , densely hairy [as for abaxial surface of leaves]; *prophylls* inserted at base of calyx, linear-ovate to linear-obovate, 4-5.5 mm long. 0.3-0.5 mm wide [length to width ratio 8.4-14, length of maximum width from base to total lamina length ratio 0.4-0.7], densely hairy, base narrowly cuneate or prophylls not constricted at base, margin incurved, apex tapering. *Calyx* green, often appearing whitish green because of the white indumentum, and lobes with purple margins or calyx purplish throughout; outer surface densely hairy [as for adaxial surface of leaves]; *tube* 2-3.3 mm long, inner surface glabrous; *lobes* narrowly triangular, 2.5-4.8 mm long, 0.8-1 mm wide [length to width ratio 1.2-1.5], inner surface moderately to densely hairy, apex tapering; [calyx lobes to tube ratio 1.2-1.5]. *Corolla* 8-12 mm long, pale mauve, with orange spots medially on abaxial surface of tube and mouth; outer surface glabrous basally, sparsely hairy on distal part of tube, densely hairy on lobes, hairs c. 0.2 mm long, ± appressed; inner surface moderately hairy in tube, sparsely hairy on base of lobes, hairs 0.2-0.7 mm long, prostrate to suberect, straight to variously bent; *tube* c. 8 mm long, tubular, dilated in throat such that tube appears slightly funnelform distally, diameter at mouth c. 5 mm; *abaxial median lobe* spathulate, 5.6-7 mm long, 7-8 mm wide distally, bilobed (sinus 0.9-3.3 mm long), each half of lobe-pair perdepressed to depressed, ovate to obovate [lobe length to width ratio 0.3-0.6] and each with a ± rounded and irregular apex; *lateral lobes* oblong to subobovate, 4.8-6 mm long, 3.4-3.9 mm wide [length to width ratio 1.3-1.7], apex rounded, slightly irregular, often slightly bilobed; *adaxial median lobe-pair* very broadly oblong, 5.2-6 mm long, c. 6 mm wide [length to width ratio 0.9-1], apex rounded to subtruncate, ± irregular, bilobed (sinus 1.8-2.6 mm long). *Androecium* inserted in mouth of corolla. *Staminal filaments* 1.7-2 mm long, glabrous or with an occasional hair; anthers 1-1.5 mm long. *Staminodal filaments* 2.9-3.3 mm long, hairy; staminodal lobes white, 0.6-1 mm long. *Disc* cylindrical, c. 0.2-0.3 mm high. *Pistil* 7-8 mm long; ovary c. 0.6 mm long; style c. 6-6.6 mm long, hairy with antrorse hairs 0.2-0.3 mm long; stigma lobes up to c. 0.3 mm long. *Mericarps* c. 1.8-2 mm long, distally extended c. 0.5-1 mm beyond base of style; seeds slightly flattened, obovate in outline, c. 1.4 mm long. Fig. 1.

DISTRIBUTION:

Endemic to the South Coast region of New South Wales.

ECOLOGY:

Confined to rhyolite rocky outcrops (at altitudes of 170-500 m) on exposed sites in *Eucalyptus sieberi-E. agglomerata* woodland with *Casuarina littoralis, Pultenaea villifera, Leptospermum attenuatum, Patersonia glabrata* and *Xanthosia pilosa,* or in more sheltered sites in *Acacia subtilinervis-Melaleuca armillaris-Kunzea ambiqua* dominated shrubland, with *Lepidosperma urophorum, Phebalium ralstonii, Platysace lanceolata* and *Hakea dactyloides.*

NOTES:

Although this species has close affinities with *W. fruticosa,* it can be readily distinguished from it. *W. davidii* has 3 leaves per whorl, pedicels that are 1.3-2 mm long, prophylls that are 4-5.5 mm long, calyx lobes longer than the calyx tube (length of calyx lobe to length of calyx tube ratio 1.2-1.5) and the indumentum is composed of subpatent to subappressed, antrorse hairs that are often slightly tangled. *W. fruticosa* has 4 or 5 leaves per whorl, pedicels that are about 0.5 mm long, prophylls (2-)2.4-3 mm long, calyx lobe less than or up to as long as the calyx tube (length of calyx lobe to length of calyx tube ratio 0.6-1) and the indumentum is composed of appressed, antrorse hairs. Each species occupies a distinct ecological niche. *W. fruticosa* is a coastal species which is usually confined


Fig. 1. *Westringia davidii.* a — twig and flowers, x 1. b — detail of flower, x 3. Both from *Albrecht 2413.* c — twig, x 1. From *Albrecht 2302.* d — detail of calyx, prophyll and indumentum, x 3. From *Albrecht 2413.*

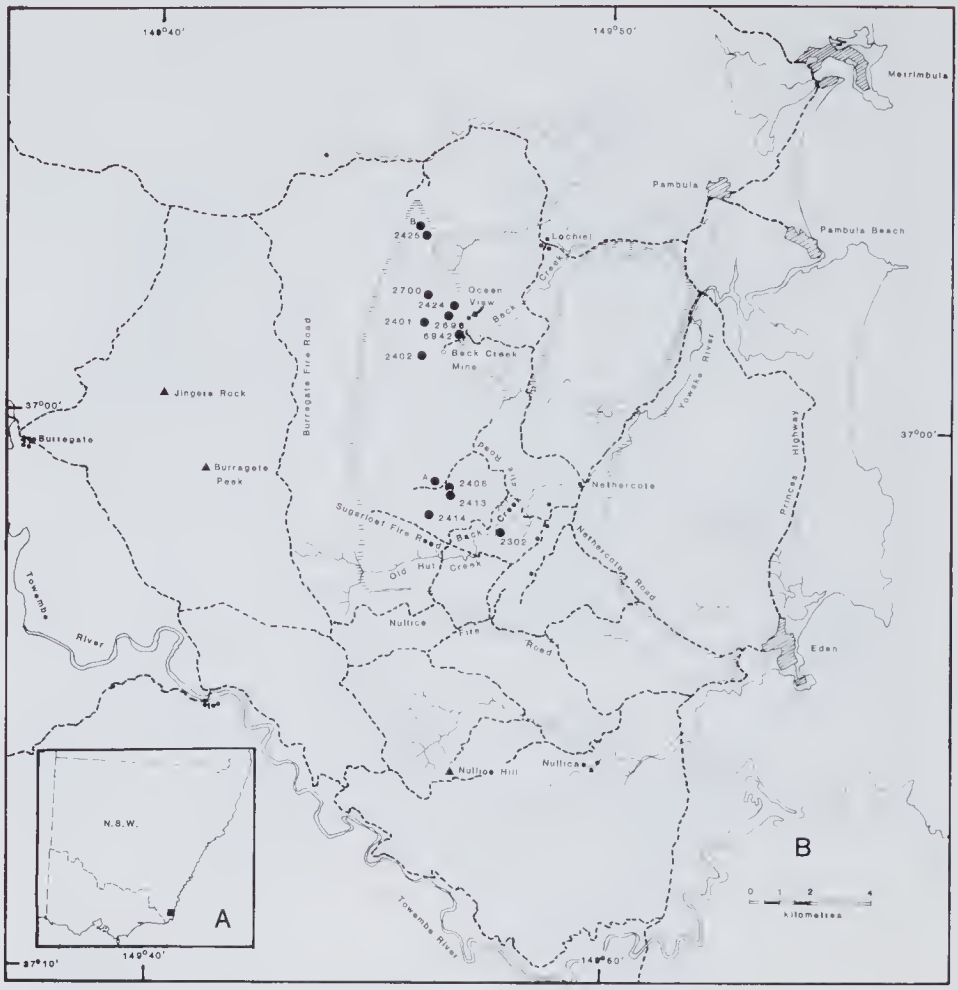


Fig. 2. Distribution map of *Westringia davidii*. a — insert map showing locality of area covered in Fig. 2b. b — detailed distribution map. Populations represented by large dots and each is numbered with an *Albrecht* collection number, except for populations 'A' and 'B' which are unvouchered sight records, and population 8942 which is a *Parris* collection number. Settlements are represented by small dots, major and minor roads by discontinuous lines, and the approximate boundary of the rhyolite is marked by horizontal lines.

to sedimentary-derived soils, at altitudes up to about 33 m, whereas *W. davidii* is confined to the rhyolite outcrops of the inland foothills at altitudes of 170 to 500 m.

Branches which develop in dense shade often have large leaves which are separated by long internodes (Fig. 1c). The branches of this species are frequently blackened by sooty moulds, which characteristically infect many species of *Westringia*. Dr B. Sutton (K) identified *Antennulariella* sp. and *Ophiocapnocoma* sp. on the branches of the specimens collected by D. E. Albrecht (see below), whereas a specimen of *W. fruticosa (Albrecht 2426,* from the Ben Boyd National Park, New South Wales) was found to be infected by two species of sooty moulds (namely, *Antennatula* sp. and a member of the family Capnodiaceae), plus a Black Yeast (*Aureobasidium pullulans*).

This species has considerable horticultural potential and has readily established at MEL (*Parris 8951*) and CBG (*Parris 8927 & 8942*) from 'cutting' material.

CONSERVATION STATUS:

An occasional or locally common shrub which is apparently restricted to the rhyolite outcrops in the Nullica & Gnupa State Forests of New South Wales (Fig. 2) — Risk Code = 2V (Leigh *et al.* 1981). This species has been assigned this rating because it only occurs in a few specific sites, the populations are not included in a conservation reserve and present management practices, particularly the 'fuel-reduction' burning practices, make this a vulnerable species.

The distribution of the known populations is shown in figure 2b. Each population is numbered according to an *Albrecht* collection number, except for populations 'A' and 'B' which are unvouchered sight records (Albrecht, pers. comm.), and population 8942 which is a *Parris* collection number. The largest known population is 2700 with about 1000 plants. Although all of the other populations are much smaller than 2700, the species is relatively widespread and common in populations 2413, 2414, 2424 and 2696. Populations 2302, 2401, 2402, 2425 and 2657 are smaller than the previous populations, with fewer plants confined to very localized areas. Occasional plants are scattered throughout population 'A', whereas only one plant was observed in population 'B'.

OTHER SPECIMENS EXAMINED:

*New South Wales: South Coast (Nullica & Gnupa State Forests) — Albrecht 2302,* 14.xii.1985, 3.2 km SW. of the Old Hut Creek crossing of the Nethercote Road (A, CANB, KUN, MEL 1546997, NSW); *Albrecht 2401,* 20.i.1986, 4.8 km SW. of Lochiel (BRI, MEL 1547001, MO); *Albrecht 2402,* 20.i.1986, 5.5 km SW. of Lochiel and c. 1 km W. of Back Creek pyrophyllite mine (MEL 1457000); *Albrecht 2406,* 21.i.1986, 1.9 km N. of the intersection of the Sugarloaf Fire Road and the Back Creek Fire Road (MEL 1546998); *Albrecht 2414,* 22.i.1986, 1 km NNW. of the intersection of the Sugarloaf Fire Road and the Back Creek Fire Road (MEL 1546999); *Albrecht 2424,* 24.i.1986, 3.7 km SW. of Lochiel and c. 0.6 km NW. of "Ocean View" property (CANB, MEL 1547002); *Albrecht 2425,* 23.i.1986, 4 km W. of Lochiel (AD, MEL 1546996); *Albrecht 2657,* 14.vii.1986, 4 km W. of Lochiel (MEL 1549250) [same locality as *Albrecht 2425]; Albrecht 2696,* 20.vii.1986, northern end of spur 800 m directly NW. of "Ocean View" property (MEL 1549251); *Albrecht 2700,* 20.vii.1986, 1.5 km directly NW. of "Ocean View" property (MEL 1549252); *Parris 8927 (& Albrecht),* 14.xii.1985, 13.1 km SW. of Pambula, above Old Hut Creek via Sugarloaf Fire Road (CBG 8505741) [same locality as *Albrecht 2302*]; *Parris 8942,* 11.i.1986, 6 km NW. of Nethercote and 9.25 km SW. of Pambula (CBG 8600430); *Parris 8951,* 22.ii.1986, c. 0.75 km NW. of "Ocean View" property (MEL 1547333) [same locality as *Albrecht 2424*].

ETYMOLOGY:

The specific epithet honours Mr David E. Albrecht of the National Herbarium of Victoria who discovered this species with M. Parris.

**Westringia saxatilis** Conn, sp. nov.

Frutices 0.5-1 m. alti. *Rami* et ramuli subteretes, dense tomentosi. *Folia* verticillata terna, dense tomentosa usque glabrescentia; *petiolus* 2-2.5 mm. longus; *lamina* anguste ovata usque anguste elliptica, 11-23 mm. longa, 3-7 mm. lata, basi cuneata usque subattenuata, margine integro et recurvo, apice acuto et brevissime mucronato. *Pedicellum floris* 0.8-1.5 mm. longus, dense tomentosus, *prophyllis* anguste oblongis vel anguste deltoideis usque linearibus, 1-1.5 mm. longis, 0.2-0.3 mm. latis, dense tomentosis. *Calyx* probabiliter viridis, extra dense tomentosus; *tubus* 3.5-5 mm. longus, intra glaber; *lobi* anguste deltoidei usque deltoidei, 3-4.5 mm. longi, 1.2-2 mm. lati, intra moderate usque dense tomentosi, apice angustato. *Corolla* 11-13 mm. longa, alba, extra in partibus moderate usque dense tomentosa, intra in partibus sparsim usque moderate tomentosa; *tubus* circa 6-8 mm. longus; *lobus abaxiali-mediano* spathulatus, 4.5-4.7 mm. longus, 5.3-5.7 mm. latus; *lobi laterales* oblongi usque subobovati, 3.2-4 mm. longi, 2.2-3.2 mm. lati; *par loborum adaxiali-medianum* transverse late oblongum usque subquadratum, 5.2-5.7 mm. longum, 5.3-6.2 mm. latum. *Androecium* ore corollae insertum; filamenta staminum 1.5-2 mm. longa; antherae 1-1.5 mm. longae; filamenta staminodiorum 1.5-2.7 mm. longa, tomentosa; lobi staminodiorum 0.6-1.3 mm. longi. *Pistillum* 7.5-8 mm. longum; ovarium circa 1 mm. longum; stylus circa 6.5-7 mm. longus, tomentosus; stigma usque ad circa 0.5 mm. longum. *Mericarpia* probabiliter immatura, circa 1.5 mm. longa.

TYPE: *Gilmour 5331*, 25.xi.1985, c. 2 km N. of Coondella Trig, Deua National Park, New South Wales (Holo.: MEL 1547004; iso.: CBG 8505381, NSW).

Shrub, 0.5-1 m high. *Branches* subterete; internodes with raised ridges from axil of leaf to next more distal node, densely hairy [c. 83-267 hairs/mm$^2$], hairs simple, ± straight, appressed to subappressed, mostly antrorse, 0.2-0.4 mm long, white. *Leaves* in whorls of 3-5, spreading, abaxial surface and petiole densely hairy [83- c. 250 hairs/mm$^2$] with ± subappressed, antrorse to retrorse, slightly tangled hairs, adaxial surface with an occasional hair or sparsely to moderately hairy [up to c. 12-68 hairs/mm$^2$], glabrescent distally; *petiole* 2-2.5 mm long; *lamina* narrow, ovate to elliptic, 11-23 mm long, 3.7 mm wide [lamina length to width ratio 2.4-4.2, length of maximum width from base to total lamina length ratio 0.4-0.6], base cuneate to subattenuate, margin entire and recurved, apex acute and very shortly mucronate (mucro c. 0.1 mm long); venation not visible, midrib raised on abaxial surface and less hairy than abaxial surface. *Inflorescence* a frondose racemiform conflorescence, uniflorescence monadic, up to c. 6-12-flowered [per conflorescence]. *Pedicel* 0.8-1.5 mm long, densely hairy [as for abaxial surface of leaves]; *prophylls* inserted at base of calyx, narrowly oblong or narrowly triangular to linear, 1-1.5 mm long, 0.2-0.3 mm wide [length to width ratio 3.3-7.5, length of maximum width from base to total lamina length ratio 0], densely hairy, prophylls not constricted at base, margin incurved, apex tapering. *Calyx* ? green; outer surface densely hairy [as for adaxial surface of leaves]; *tube* 3.5-5 mm long, inner surface glabrous; *lobes* narrowly triangular to triangular, 3-4.5 mm long, 1.2-2 mm wide [length to width ratio 1.5-3], inner surface moderately to densely hairy, apex tapering; [calyx lobes to tube ratio 0.7-1]. *Corolla* 11-13 mm long, white, with yellowish (*Binns s.n.* MEL 670211) [probably brownish orange] spots medially on abaxial surface of tube and mouth; outer surface glabrous basally, sparsely to densely hairy on distal part of tube, densely hairy on lobes, hairs 0.1-0.4 mm long, ± appressed; inner surface glabrous in tube, glabrous or sparsely to moderately hairy on base of lobes, hairs 0.2-1 mm long, prostrate to suberect, straight to variously bent, slightly flattened; *tube* c. 6-8 mm long, tubular, dilated in throat such that tube appears slightly funnelform distally, diameter at mouth c. 4-5 mm; *abaxial median lobe* spathulate, 4.5-5.7 mm long, 5.3-5.7 mm wide distally, bilobed (sinus up to c. 1 mm long), each half of lobe-pair perdepressed to very broadly ovate [lobe length to width ratio 0.4-0.8] and each with a ± rounded and irregular apex; *lateral lobes* oblong to subobovate, 3.2-4 mm long, 2.2-3.2 mm wide [length to width ratio 1-1.6], apex rounded, slightly irregular, often slightly bilobed; *adaxial median lobe-pair* transversely broad-oblong to almost square, 5.2-5.7 mm long, 5.3-6.2 mm wide [length to width ratio 0.8-1], apex rounded to subtruncate, ± irregular, bilobed (sinus 1.6-2.6 mm long). *Androecium* inserted in mouth of corolla. *Staminal filaments* 1.5-2 mm long, glabrous or with an occasional hair; anthers 1-1.5 mm long. *Staminodal filaments* 1.5-2.7 mm long, hairy; staminodal lobes white, 0.6-1.3 mm long. *Disc* cylindrical, c. 0.2-0.3 mm high. *Pistil* 7.5-8 mm long; ovary c. 1 mm long; style c. 6.5-7 mm long, hairy with antrorse hairs 0.2-0.3 mm long; stigma lobes up to c. 0.5 mm long. *Mericarps* ? immature, c. 1.5 mm long, distally extended c. 0.8 mm beyond base of style; seeds ? immature, slightly flattened, obovate in outline, c. 1 mm long. Fig. 3.

DISTRIBUTION:

Endemic to the Deua National Park, in the South Coast region of New South Wales.

ECOLOGY:

Confined to steep rhyolite rocky outcrops (at altitudes of 450-540 m) in skeletal soils of *Eucalyptus stenostoma-Hakea macraeana* shrubland-open forest, with *Hakea dactyloides, Casuarina littoralis, Eriostemon trachyphyllus, Prostanthera porcata, Leucopogon setiger* and *Leptospermum* sp. nov.


Fig. 3. *Westringia saxatilis*. a — twig and flowers, x 1. b — detail of indumentum, x 3. c — detail of calyx and prophylls, x 3. All from *Gilmour 5331*.

NOTES:

This species has its closest affinities with *W. fruticosa*. *W. saxatilis* has pedicels that are 0.8-1.5 mm long (about 0.5 mm long in *W. fruticosa*) and prophylls that are 1-1.5 mm long and 0.2-0.3 mm wide (usually 2.4-3 mm long and 0.3-0.5 mm wide in *W. fruticosa*). *W. saxatilis* is restricted to the rhyolite outcrops of the inland foothills regions of New South Wales (at altitudes of 450-540 m), whereas the more widespread *W. fruticosa* is confined to the coast (at altitudes up to c. 33 m).

CONSERVATION STATUS:

An occasional or locally common shrub which is restricted to the rhyolite outcrops in the Deua National Park — Risk Code = 2R (Leigh *et al.* 1981).

OTHER SPECIMENS EXAMINED:

*New South Wales: South Coast (Deua National Park) — Beesley (& Binns) 368,* 28.iii.1985, ridge 1.8 km NE. of summit of Mt Donovan (AD, CBG 8502583, MEL 1549253, NSW); *Binns s.n.,* 27.iii.1985, Mt Donovan (MEL 670211); *Gilmour 4310*, 15.ii.1984, c. 2 km N. of Coondella Trig (CBG 8413618); *Gilmour 5330*, 25.xi.1985, c. 2 km N. of Coondella Trig (CBG 8505380, MEL 1547005, NSW).

## ACKNOWLEDGEMENTS

I wish to thank D. E. Albrecht (MEL) and P. Gilmour (National Parks and Wildlife Service, Queanbeyan) for drawing my attention to these two new species and for providing ecological information. M. Parris (Merimbula) kindly provided cutting material of *W. davidii* for cultivation at MEL. The plant illustrations were skilfully done by R.H. Barley (MEL).

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Manuscript received 1 July 1986.

# NOTES ON THE WOOD ANATOMY OF IDIOSPERMUM AUSTRALIENSE (IDIOSPERMACEAE)

by

D. B. FOREMAN*

## ABSTRACT

Foreman, D. B. Notes on the wood anatomy of *Idiospermum australiense* (Idiospermaceae). *Muelleria* 6(5): 329-333 (1987). — Results of a study of the wood of *Idiospermum australiense* using scanning electron microscopy confirm that in mature secondary xylem exclusively simple perforation plates are present whereas in the secondary xylem of seedlings simple perforation plates as well as a few scalariform perforation plates with up to about five bars are found. Earlier reports that had indicated multiple scalariform or scalariform perforation plates were features of the mature secondary xylem are clearly erroneous. Idiospermaceae appears to occupy an isolated position in the Laurales, allied to Calycanthaceae.

## INTRODUCTION

Following the rediscovery in 1971 of *Idiospermum australiense* (Diels) S.T. Blake (*Calycanthus australiensis* Diels) in the Daintree region of north Queensland, after it had been implicated in the poisoning of a number of cattle at Noah Creek, there has been keen interest in the plant. It appeared to occupy an interesting position amongst the putatively primitive angiosperms because of its distinctive wood anatomy and peculiar embryo structure.

This paper is an expansion of a poster presented at *The Ecology of Australia's Wet Tropics 1986 Conference* held in Brisbane, Queensland, from 25-27 August 1986.

## METHOD AND MATERIALS

A small piece of wood taken from the stem of a mature tree grown in its natural habitat was obtained from B.P.M. Hyland, QRS, Atherton, north Queensland.

Seedlings were grown in the Department of Botany glasshouse at the University of New England from seed collected by B.J. Wallace in 1979 from the Daintree region in north Queensland. Vouchers for the specimens are lodged at QRS and NE respectively.

The wood was trimmed with a razor blade to a cube about 0.5 cm square, air dried, then sputter coated with a thin layer of gold and examined with a JEOL JSM-35 SEM.

## OBSERVATIONS

Secondary xylem from the wood sample obtained from the stem of the tree grown in its natural habitat was found to have vessel elements with exclusively simple perforation plates in moderately oblique to almost transverse end walls (Fig. 1a). Most of the vessel elements seen in this sample were about 200 $\mu$m in diameter and from 300-500 $\mu$m in length. Intervessel pitting is alternate, crowded and with the pit apertures being narrow-elliptic (Fig. 1b). The pitting between the vessel elements and the ray and axial parenchyma showed considerable variation in form and orientation. Most of the pits are elliptic but some are circular or linear. The pits may be oriented obliquely, vertically or horizontally (Fig. 1c).

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The vessel elements in the secondary xylem of the seedling root were about 100 μm in diameter and about 350-400 μm in length (Fig. 1d). They appeared to lack the linear pits present in the secondary xylem of the tree stem. Exclusively simple perforation plates were found in the samples examined.

The diameter of the vessel elements from the secondary xylem of the seedling stem also showed a decrease in diameter, many averaging between 50-75 μm. These vessel elements, like those from the tree stem, had occasional linear pits which were at times arranged in a more or less vertical pattern (Fig. 1e). In addition to simple perforation plates identical to those found in the secondary xylem of the tree stem and seedling root a few scalariform perforation plates with about 5 bars were found in the wood sample taken from the seedling stem. A few reticulate connections were observed between some of the bars (Fig. 1e).

## DISCUSSION

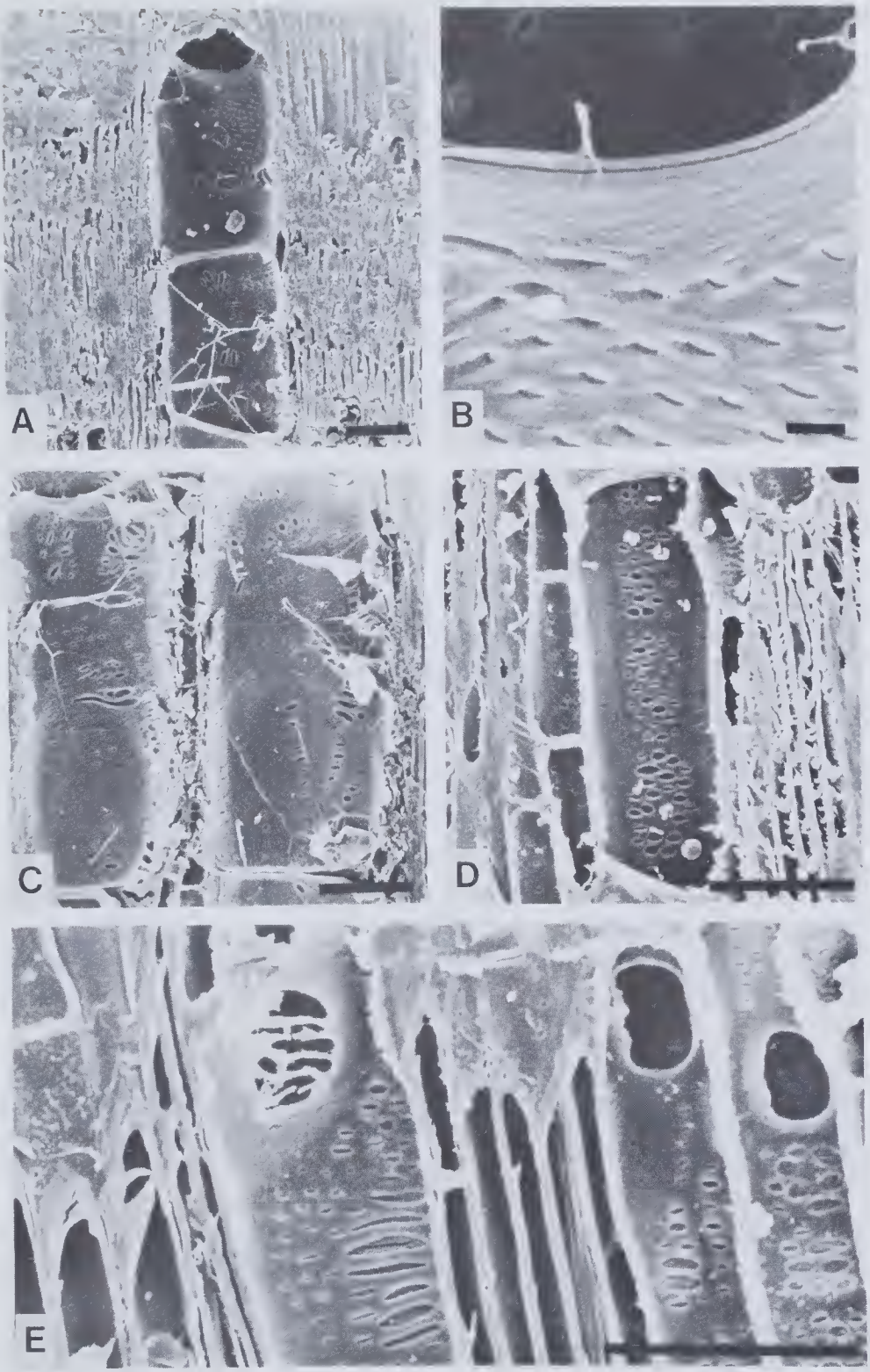
Until the rediscovery of *Idiospermum australiensis* in 1971 its fruits were unknown. According to Blake (1972) the peculiar embryo with its 3-4 quite distinct, massive, subsessile cotyledons were unlike any other family previously described. From notes supplied by Mr W.J. Smith (Blake, 1972) it was also apparent that the wood of *I. australiensis* was distinctive and reportedly included the feature "vessel perforations multiple, scalariform." Primarily on the basis of the peculiar embryo and the distinctive wood found in *I. australiensis* Blake (1972) not only described a new genus *Idiospermum* but also placed it in a new family the *Idiospermaceae.*

If the report of multiple scalariform perforation plates in the secondary xylem of *Idiospermum* was accurate it would have been an unusual feature indeed amongst the extant putatively primitive angiosperms. Apart from families such as Winteraceae, which lack vessels and which have tracheids with scalariform pits in their oblique end walls, most other putatively primitive angiosperms have vessel elements with scalariform perforation plates in very oblique to oblique end walls. A few taxa, such as *Palmeria* F. Muell. (Monimiaceae), have simple perforation plates in oblique to almost transverse end walls.

Lamont (1974) reported briefly on *Idiospermum,* calling it "a living primitive angiosperm." According to his report, *Idiospermum* possessed 13 primitive characters including secondary xylem with vessels having scalariform end-plates and side walls. This work was based partly on the earlier account by Blake (1972).

Following a detailed study, Wilson (1976, 1979) described and discussed various aspects of the floral and vegetative anatomy of *Idiospermum,* comparing many of the features with members of the Calycanthaceae. As a result of these studies Wilson (1979) was unable to confirm the presence of multiple scalariform perforation plates which had previously been reported by Smith in Blake (1972) or scalariform end plates and side walls as reported by Lamont (1974). Wilson (1979) reported finding exclusively simple perforation plates in moderately oblique to almost transverse end walls in the wood sample he examined. In addition, Wilson (1979) also reported finding conspicuous pitting between vessel elements and ray and axial parenchyma which varied greatly in form and size. The pits ranged in shape from circular to strongly elliptical or linear with typical linear pits being about three times longer than wide (average 22 μm in length). The elliptic and linear pits were found to be horizontally, obliquely, or vertically oriented. These findings are in

Fig. 1. *Idiospermum australiense.* a—L.S. of vessel elements from tree grown in natural habitat showing simple perforation plates in moderately oblique to almost transverse end walls. Bar = 100 μm. b—Portion of vessel element from tree grown in natural habitat showing intervessel pitting. Bar = 10 μm. c—L.S. of vessel elements from tree grown in natural habitat showing the variety of pitting between vessel elements and the ray and axial parenchyma. Bar = 100 μm. d—L.S. of vessel elements from seedling root. Bar = 100 μm. e—L.S. of vessel elements from seedling stem showing a scalariform perforation plate, several simple perforation plates and vertically arranged linear pits. Bar = 100 μm.


A
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C
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E

agreement with those of the present study for the wood obtained from a tree grown in its natural habitat. The close agreement between the findings of Wilson (1979) and some aspects of the present observations is not surprising since wood samples for both studies were obtained from the same source.

Unfortunately the misleading report (Blake, 1972) of exclusively scalariform perforation plates in *Idiospermum* has been perpetuated in Cronquist (1981) for it would appear that the work of Wilson (1979) was not published in time for it to have been considered by Cronquist.

From the scanning electron-micrographs it may be difficult to imagine how the initial misinterpretation given in Blake (1972) could have been made. However, when a radial longitudinal section of secondary xylem (Wilson 1979, Fig. 19) is examined under a light microscope it is much easier to understand how the confusion could have risen. The variety of pitting between the vessel elements and the ray and axial parenchyma is clearly seen in a radial longitudinal section of the wood of *Idiospermum*. In particular the linear or strongly elliptical pits when arranged in a vertical fashion could give the impression of a scalariform perforation plate (Fig. 5). When a number of pits occur in close proximity to each other they could possibly be mistaken for scalariform perforation plates in the side walls of the vessel elements or even for multiple scalariform perforation plates in the end walls of vessel elements.

The discovery of scalariform perforation plates in young stems of *Idiospermum* in a taxon which otherwise has simple perforation plates is not a unique occurrence amongst the putatively primitive angiosperms. The Himantandraceae, a family placed by Cronquist (1981) in the order Magnoliales but which also has some affinities with the Laurales, has vessel elements with simple perforation plates although in young stems some of the perforation plates may be scalariform. In the Monimiaceae (*s.l.*), a key family to the understanding of relationships in the Laurales, some taxa such as *Bracteanthus glycycarpus* Ducke (Araujo & Filho, 1973b) and *Siparuna bifida* (Poeppig & Endl.) A.DC (Araujo & Filho, 1973a) also have a combination of simple perforation plates and scalariform perforation plates with up to seven bars.

Dahlgren (1980), Takhtajan (1980) and Thorne (1981) all include *Idiospermum* in the Calycanthaceae with the latter two authors recognising the taxon at sub-family level. The work of Wilson (1979) supports the relationship between the Idiospermaceae and the Calycanthaceae and also the recognition by Blake (1972) and Cronquist (1981) of the Idiospermaceae at family level.

Cronquist (1981) considers the Idiospermaceae to be part of his order Laurales where it occupies a somewhat isolated position allied to the Calycanthaceae. While there is some disagreement amongst the authors as to the status of the Idiospermaceae there appears to be general agreement about its placement amongst the Lauralean families.

## ACKNOWLEDGEMENTS

Thanks are due to Mr B.P.M. Hyland, Queensland Research Station, C.S.I.R.O., Atherton, for providing a wood sample of *Idiospermum* and to Mr M. Speak and Mr P. Garlick from the University of New England, Armidale, for help with the electron microscopy.

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# STUDIES IN ANTARCTIC LICHENS 6: FURTHER NOTES ON UMBILICARIA

by

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## ABSTRACT

Filson, Rex B. Studies in Antarctic lichens 6: further notes on *Umbilicaria*. *Muelleria* 6(5): 335-347 (1987). — Five species of *Umbilicaria* are enumerated for Continental Antarctica, South Shetland Islands, South Orkney Islands and the off-shore islands of the Antarctic continent (Fig. 1): *U. aprina* Nyl., *U. cristata* Dodge & Baker, *U. decussata* (Vill.) Zahlbr., *U. propagulifera* (Vainio) Llano and *U. rufidula* Hue. A key to species is given and a full description and distribution map of each species is provided. *U. antarctica* Frey & Lamb and *U. dillenii* Tuck. var. *solida* Frey are placed in synonymy under *U. rufidula* Hue; *U. saviczii* Llano and *Gyrophora korotkeviczii* Golubkova are placed in synonymy under *U. aprina* and *Dermatiscum mawsoni* Dodge is placed in synonymy under *U. decussata*. The validity of all other taxa within the Umbilicariaceae described from the region is discussed.

## INTRODUCTION

This paper is a continuation of a series of papers on the lichens of Antarctica (Filson 1974a,b; Filson 1975 a,b,c).

In a paper enumerating the lichens collected on the Windmill Islands, Wilkes Land, (Filson 1974b) I accepted two species of *Umbilicaria*; *U. cristata* Dodge & Baker, a species with a few tufts of rhizines on the lower surface, and *U. decussata* (Vill.) Zahlbr., a species without rhizines below. In a further paper (Filson 1975b) I discussed the possibility of two rhizinate species being present on the Antarctic Continent, one, *U. antarctica* Frey & Lamb, occurring along the Antarctic Peninsula region in western Antarctica and the other, *U. aprina* Nyl., occurring in eastern Antarctica. Since writing those papers I have had the opportunity of examining all of the *Umbilicaria* collection from Antarctica housed in the British Museum (Natural History) together with several other modern collections (see acknowledgements). I now consider that there are five species of *Umbilicaria* in the area under discussion and have found that nomenclatural changes are required.

## BRIEF SUMMARY OF PREVIOUS WORK

In the 'Lichen Flora of the Antarctic Continent and Adjacent Islands', Dodge (1973) divided the Umbilicariaceae into five genera, *Agyrophora, Omphalodiscus, Llanoa, Umbilicaria* and *Dermatiscum*. Within these five genera he recognised the following fifteen taxa — *Agyrophora nana* (Vainio) Dodge, *Omphalodiscus antarctica* (Frey & Lamb) Llano, *O. bakeri* Dodge, [nom. superfl.], *O. eximius* (Hue) Dodge, *O. spongiosus* (Dodge & Baker) Llano, *O. spongiosus* var. *subvirginus* (Frey & Lamb) Dodge, *O. subcerebriformis* (Dodge) Dodge, *Llanoa cerebriformis* (Dodge & Baker) Dodge, *Umbilicaria cristata* Dodge & Baker, *U. hunteri* Dodge, *U. parvula* Hue, *U. pateriformis* Dodge & Baker, *U. propagulifera* (Vainio) Llano [wrongly cited (Räs.) Llano], *Dermatiscum harrisonii* Dodge, and *D. mawsonii* Dodge.

In his account Dodge placed *U. dillenii* Vainio, *U. rufidula* Hue and *U. dillenii* var. *solida* Frey within the taxon *Omphalodiscus antarcticus*. He proposed *O. bakeri* as a new name for *Umbilicaria rugosa* Dodge & Baker, which he reported as a later homonym of *Gyrophora rugosa* Hook. However, I cannot find where the

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epithet *rugosa* has been used in combination with *Omphalodiscus* and therefore *O. bakeri* is nomenclaturally superfluous and illegitimate (ICBN, Art. 63).

Llano (1950) listed seven taxa of Umbilicariaceae as occurring in Antarctica, namely *Omphalodiscus antarcticus* (Frey & Lamb) [as 'Lamb & Frey'] Llano, *O. antarcticus* var. *cerebriformis* (Dodge & Baker) Llano, *O. spongiosus* (Dodge & Baker) Llano, *Umbilicaria cristata* Dodge & Baker, *U. propagulifera* (Vain.) Räs. Llano, *U. solida* (Frey) Llano and *Agyrophora leiocarpa* var. *nana* (Vain.)Llano. In this paper he placed *Umbilicaria antarctica* var. *subvirginis* in synonymy with *Omphalodiscus spongiosus, U. rufidula* with *O. antarcticus,* and *U. eximia, U. rugosa, U. hunteri* and *U. pateriformis* with *O. decussatus.*

Lindsay (1969) enumerated five species of *Umbilicaria* for the Peninsula region of Antarctica (Fig.1.), these being *Omphalodiscus antarcticus* (Frey & Lamb) Llano, *O. decussatus* (Vill.) Schol., *O. spongiosus* (Dodge & Baker) Llano, *Umbilicaria propagulifera* (Vain.) Llano and *U. cristata* Dodge & Baker. In a later paper (Lindsay 1972) he cited two species from Vestfjella, *U. aprina* Nyl. and *U. decussata,* with the note that *U. aprina* appeared very similar to *U. spongiosa.*

Øvstedal (1983, a & b, 1986) also reported *U. aprina* and *U. decussata* from the mountains of Dronning Maud Land (Fig.1).

Seppelt (1986) recorded the same two species from the Vestfold Hills, Princess Elizabeth Land (Fig.1). He placed *U. dillenii* Vain., *U. dillenii* var. *solida* Frey, *U. rufidula* Hue, *Charcotia rufidula* Hue, *U. solida* Llano, *U. antarctica* Frey & Lamb, *U. antarctica* var. *subvirginis* Frey & Lamb, *Omphalodiscus antarcticus* (Frey & Lamb) Llano, *O. spongiosus* (Dodge & Baker) Llano, *O. spongiosus* var. *subvirginis* (Frey & Lamb) Dodge, *U. spongiosa* Dodge & Baker, *U. spongiosa* var. *subvirginis* (Frey & Lamb) Dodge, *?O. bakeri* Dodge and *?U. rugosa* Dodge & Baker in synonymy with *U. aprina.*

Poelt (1974) has suggested that the genus *Dermatiscum* be placed in a family of its own the Dermatiscaceae, as its affinities lie with the Physciaceae rather than the Umbilicariaceae. The species *Dermatiscum harissoni* Dodge was described (Dodge 1948) from a "single fragmented collection, separated from other lichens, on dead mosses. It is evidently old and weathered, which may account for the browning of the medullary tissue. The species is somewhat aberrant in the genus in being attached to the substrate by abundant single brown hyphae, rather than by a central hapteron and by much slenderer hyphae throughout the thallus but its algae are clearly Trentepohlioid . . .". Unfortunately the single fragmentary collection A.A.E. 56-1 could not be located so it is impossible to know where this specimen should be placed. However from the description provided it is evident that the material does not belong in the Umbilicariaceae.

Additional comments on the above taxa are included in the discussions under the relevant species.

## TAXONOMIC CRITERIA AND ASSESSMENT OF SPECIMENS

The above brief summary shows that most authors have divided this family into a number of genera. However generic divisions within the Umbilicariaceae based on apothecium morphology alone leads to unnatural groupings and the maintenance of one single genus is supported by ontogenetical studies (Henssen 1970). The presence of "Brutkörner" or "thallospores" are considered as being conidia of the mycobiont and are characteristic of species (Hassenhüttl and Poelt 1978).

Selected specimens from each of the four species were examined by thin layer chromatography which proved to be of little use in the separation of species.

Fertile specimens are very rare in Antarctica. The only fertile specimens which I have seen, have been collected in the Peninsula region in eastern Antarctica and in the Antarctic Islands just to the north. It would appear that these are the only regions where climatic conditions are suitable for a thallus to produce fruiting bodies.

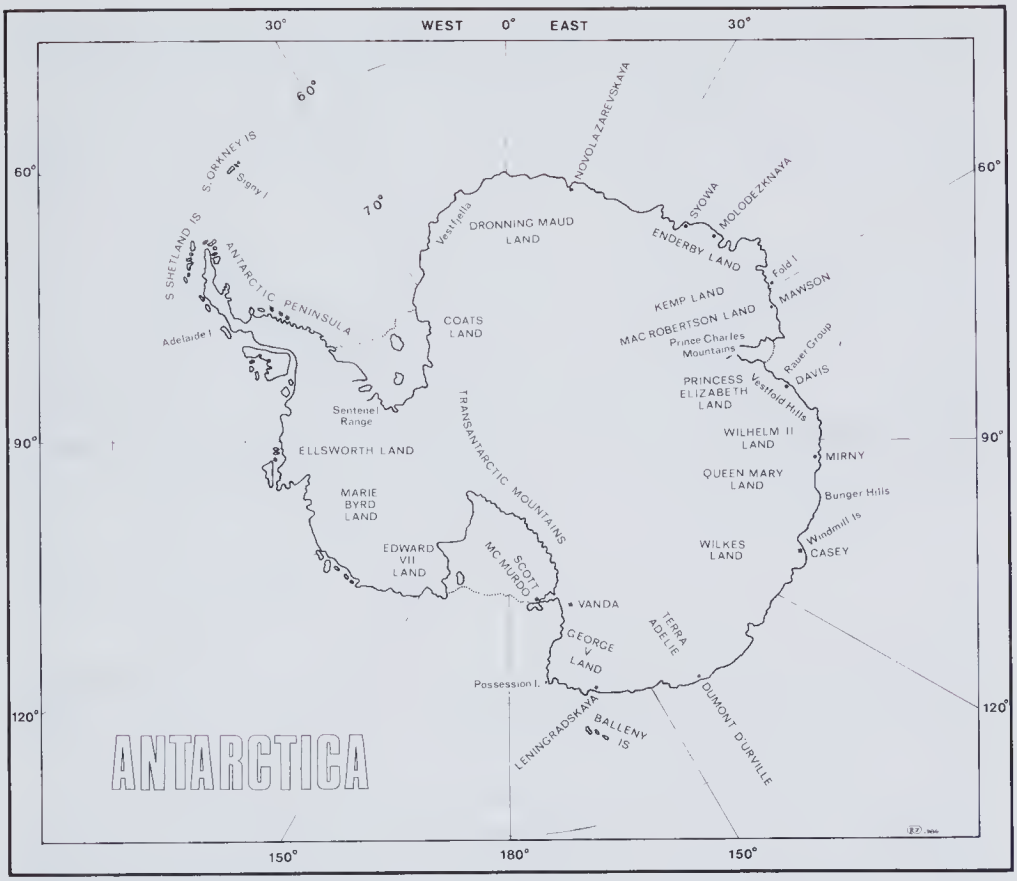


Fig. 1. Map of Antarctica showing localities referred to in the text and reference points for the distribution maps (see Fig. 3.).

I have examined over 350 complete specimens, mostly still attached to the substrate. In addition, there are many packets of fragments in herbaria, with a multitude of names. I have assigned them by virtue of their undersurface, or nature of the rhizines, to the species named in this paper. None appear to me to have any special characters which would warrant their segregation as distinct species.

A complete list of specimens examined is available from the National Herbarium of Victoria (MEL).

## TAXONOMY

### Key to Species of Umbilicaria in the Antarctic

1. Undersurface with rhizines
   2. Rhizines dense, sometimes with a bare patch around the umbilicus, simple, dichotomous or strap-like
      3. Upper surface smooth to lightly ridged; margins sometimes rolled under, never subvertical, ragged and torn; underside black; thallospores always thick and conspicuous .... *U. rufidula*
      3. Upper surface granulose, wrinkled to deeply ridged; margins flexuose, often subvertical; underside pale pinkish-brown to sooty-brown to black; thallospores often inconspicious, but sometimes thick and conspicuous ..... *U. aprina*
   2. Rhizines sparse, sometimes only marginal, simple to much branched
      4. Rhizines irregularly branched many times; thallospores thick and conspicuous ..... *U. propagulifera*
      4. Rhizines simple or several times dichotomously branched; thallospores sparse and inconspicuous ..... *U. cristata*
1. Undersurface erhizinate ..... *U. decussata*

**Umbilicaria aprina** Nyl., Synops. Lich. 2: 12 (1863). TYPE: "In monte Dedschen Abyssiniae lecta a cl. W. Shimper, altitudine 14200 pedum supra mare." HOLOTYPE: "Abyssinia, Dedschen altit. 14200 pedum. W. Schimper." (H-NYL 31742!).

*Umbilicaria spongiosa* Dodge & Baker, Ann. Mo. bot. Gnd. 25: 566 (1938). — *Omphalodiscus spongiosus* (Dodge & Baker) Llano, Monogr. Umbil.: 91 (1950). — *Gyrophora spongiosa* (Dodge & Baker) Golubkova & Savicz, Nov. Syst. Vysshikh. Rast. 3: 259 (1966).TYPE: "Marie Byrd Land, Edsel Ford Range, Lichen Peak, P. Siple & S. Corey 73-9. HOLOTYPE: "Marie Byrd Land Lichen Peak Siple & Corey 73-9." (Herb. Dodge!).

*Umbilicaria antarctica* var. *subvirginis* Frey & Lamb, Trans. Br. Mycol. Soc. 22: 272 (1939). — *Umbilicaria spongiosa* var. *subvirginis* (Frey & Lamb) Dodge, B.A.N.Z. Antarct. Exped. 1929-31 Rep. Ser., B. Zool.-Bot. 7: 148 (1948). — *Gyrophora spongiosa* var. *subvirginis* (Frey & Lamb) [as "Lamb & Frey"] Golubkova & Savicz, Nov. Syst. Vysshikh. Rast. 3: 260 (1966). — *Omphalodiscus spongiosus* var. *subvirginis* (Frey & Lamb) Dodge, Antarct. Lich.: 124 (1973). TYPE: "Regio antarctica: South Victoria Land, Cape Sastrugi, Evans Cove, leg. British Antarctic Expedition Terra Nova, 1910.". HOLOTYPE: "Cape Sastrugi Evans Cove det. O.V. Darbishire." (BM!).

*Umbilicaria saviczii* Llano, Bryologist 69: 110 (1966). TYPE: "Antarctica. Princess Astrid Coast. Novolazarevskaya, 70° 46′S, 11° 50′E, Meyer 6." (Llano, p.111 says "US — holotype" however a search at that herbarium (Hale, pers. comm.) and at ABSL (Wetmore, pers. comm.), where the major part of the Llano herbarium has been deposited, has failed to locate the type specimen).

*Gyrophora korotkeviczii* Golubkova, Nov. Syst. Vysshikh. Rast. 3: 261 (1966). TYPE: "Antarctida Orientalis, Litus Pravda, Bunger Hills ad saxa 3 III 1957; E.S. Korotkevicz.". HOLOTYPE: "Antarctida Orientalis, litus Pravda, Bunger Hills, ad saxa. E.S. Korotkevicz 523. 3.III. 1957." (LE!).

*Thallus* foliose, thick, leathery, monophyllous, deeply incised, often appearing polyphyllous, very variable in size and shape from small rosulate thalli, less than 1 cm diam., to large foliose thalli to 10 cm diam.; margins flexuose, often subvertical, at times bordered with a white necrotic zone; sometimes several thalli growing together in tightly compressed colonies; upper surface light buff to mummy-brown, grey to almost black, dull, pruinose or sometimes covered with a thick necrotic layer, granulose, indistinctly cracked, wrinkled to reticulately rugose and often paler above the umbo, fading to the margins; lower surface pale pinkish-brown to sooty-brown to black; thallospores farinose, inconspicuous on paler thalli but thick and conspicuous on those with a black undersurface; rhizines moderate to dense, thinning to a narrow bare zone around the umbilicus, simple to sparingly branched, occasionally fasciculate, cylindrical to strap-like, variously coloured, mostly lighter than the undersurface of the thallus, sometimes grading from dark at the base to light at the tips, rarely evenly dark coloured; thallospores thick on darker rhizines absent on lighter. *Apothecia* not seen.

DISTRIBUTION: Fig. 3a.

DISCUSSION:

Lindsay (1972) first reported the presence of this species on the Antarctic continent. He suggested that it appeared similar to *Umbilicaria spongiosa* Dodge & Baker, an observation confirmed by Filson (1975b).

I have discussed the type specimen of *Umbilicaria spongiosa* and *U. antarctica* var. *subvirginis* elsewhere (Filson 1975b).

The holotype specimen of *Gyrophora korotkeviczii* consists of two complete thalli and three thalline fragments. The thalli are small, to 20 mm diam.; upper surface smooth, pale buff; lower surface pale pinkish-brown at the margins, becoming sooty-brown towards the centre; rhizines concolourous to paler than the lower surface, sparingly branched. In all respects they agree with the typical "young,

smooth thallus form'' of *U. aprina*. These specimens were possibly growing in a sheltered site.

In the protologue, *U. saviczii* is said to differ from the ''virginis — crustulosus — spodochrous complex'' by the ''parti-coloured lower surface and the highly branched rhizines''. Species of this complex were not reported from the Antarctic (Llano 1950), however the description of *U. saviczii* agrees well with specimens of *U. aprina* found on Continental Antarctica.

**Umbilicaria cristata** Dodge & Baker, Ann. Mo. bot. Gdn. 25: 565 (1938). TYPE: ''King Edward VII Land, Rockefeller Mts., Mt. Helen Washington, P. Siple, F.A. Wade, S. Corey & O.D. Stancliff HW-1a.''. HOLOTYPE: (n.v.).

*Thallus* foliose, monophyllous, to 10 mm diam.; margins smooth, flexuose, crenate, incised, bare or thickly beset with rhizines; upper surface dull, grey-brown, smooth, rugulose and occasionally pruinose over the umbilicus; lower surface dirty white to pinkish-brown, thinly covered with thallospores; thallospores thicker in the marginal rhizinate zone; rhizines black, mostly well developed, to 2 mm long, simple to many times dichotomously branched, bare or thinly covered with thallospores. *Apothecia* and *pycnidia* not seen.

DISTRIBUTION: Fig. 3b.

DISCUSSION:

*Umbilicaria cristata* is a very small species characterised by the long, dichotomously branched, marginal rhizines. Unfortunately I have not been able to borrow the type. However, there is a specimen in the National Herbarium of Victoria determined by Dodge and cited in his BANZARE report (Dodge 1948) as *U. cristata* (A.A.E. 60-2). This specimen consists of several fragments of more than one thallus with branched rhizines and one almost complete erhizinate thallus. The latter can be referred to *U. decussata*. Llano (1950) keys out the ''Antarctic species'' of *Umbilicaria* separately from the others in the Western Hemisphere but does not give any clear distinction between *U. cristata* and *U. propagulifera*. He stated: ''This species [*U. cristata*] has been recorded from two widely separated localities in the Antarctic; it may well be circumpolar. It is quite distinct, morphologically from *U. propagulifera* Vain. but both of these species are known only sterile. Both appear to be somewhat similar to *U. cylindrica* but there is no proof that they may be referrable to that species.''

Under *U. propagulifera* Llano wrote that ''Sterile Umbilicariaceae with rhizinate margins are usually conferable to *U. cylindrica* as Vainio apparently did with this material [*Gyrophora cylindrica* var. *propagulifera*]. However, when compared with the many varieties of *U. cylindrica*, it may be seen that Vainio's variety exhibits strong dissimilarities.''. Again Llano does not say what dissimilarities, nor does he give any further discussion or reasons why he considers them to be distinct species.

I have examined additional material from ''summit 706 m'' east of Swinhoe Peak, South Georgia. These specimens clearly illustrate the difference between the rhizines and thallospores of this species and *U. propagulifera*.

**Umbilicaria decussata** (Vill.) Zahlbr., Cat. Lich. Univ. 8: 490 (1942). — *Lichen decussatus* Vill., Hist. Plant. Dauphiné 3: 964 (1789). — *Omphalodiscus decussatus* (Vill.) Schol., Nytt Mag. Naturvid. 75: 23 (1934). TYPE: ''Il croit sur les rochers granitiques des hautes Alpes, du Valgaudemar, de Champoleon, de Chaillol-le-Vieux, &c.''. HOLOTYPE: Villars 1789, Hist. Plant Dauphine pl. LV.

*Umbilicaria eximia* Hue, Deux. Expéd. Antarct. Franç. 1908-10, Sci. nat., doc. sci.: 55 (1915). — *Omphalodiscus eximius* (Hue) Dodge, Antarct. Lich.: 122 (1973). TYPE: ''Ile Jenny, baie Marguerite, sur les pierres des éboulis, très abondant, XIIe

excursion, no 226 altitude 380 mètres, et no 227, altitude 75 mètres, no 228, le 15 janvier 1909.". LECTOTYPE (here chosen): "2° exped. antarct. française 1908-1910 no 227 pour partie." (PC!).

*Umbilicaria parvula* Hue, Deux. Expéd. Antarct. Franç. 1908-10, Sci. nat., doc. sci.: 56 (1915). — *Gyrophora parvula* (Hue) Zahlbr., Cat. Lich. Univ. 4: 720 (1927). TYPE: Petite ile dans la baie Marguerite, sur les rochers (diorites), XVe excursion, no 267, 24 janvier 1909.". LECTOTYPE (here chosen): "2° exped. Antarct Française 1908-10 no 267 pr. partie." (PC!).

*Umbilicaria rugosa* Dodge & Baker, Ann. Mo. bot. Gdn. 25: 561 (1938), non J.D. Hook. in Kunth., Syn. Pl. Aequinoct. Orb. Nov. 1: 16 (1822). — *Omphalodiscus bakeri* Dodge, Antarct. Lich.: 120 (1973). TYPE: "King Edward V11 Land, Rockefeller Mts., Mt. Helen Washington, P. Siple, F.A. Wade, S. Corey & O.D. Stancliff HW-12.". HOLOTYPE: (n.v.).

*Umbilicaria cerebriformis* Dodge & Baker, Ann. Mo. bot. Gdn. 25: 562 (1938). — *Charcotia cerebriformis* (Dodge & Baker) Dodge, B.A.N.Z. Antarct. Res. Exped. 1929-31 Rep. Ser., B. Zool.-Bot. 7: 150 (1948). — *Omphalodiscus decussatus* var. *cerebriformis* (Dodge & Baker) Llano, Monogr. Umbil.: 83 (1950). — *Llanoa cerebriformis* (Dodge & Baker) Dodge, Antarct. Lich.: 127 (1973). TYPE: "Marie Byrd Land, Edsel Ford Range, Skua Gull Peak, P. Siple & S. Corey 72W-15.". HOLOTYPE: (n.v.).

*Umbilicaria pateriformis* Dodge & Baker, Ann. Mo. bot. Gdn. 25: 564 (1938). TYPE: "Marie Byrd Land, Edsel Ford Range, Skua Gull Mt., P. Siple & S. Corey 72W-13.". HOLOTYPE: (n.v.).

*Umbilicaria hunteri* Dodge, B.A.N.Z. Antarct. Res. Exped. 1929-31, Rep. Ser., B. Zool.-Bot. 7: 148 (1948). TYPE: "King George V Land, Cape Denison, J.G. Hunter 21, A.A.E. 21.". HOLOTYPE: (n.v.).

*Umbilicaria subcerebriformis* Dodge, B.A.N.Z. Antarct. Res. Exped. 1929-31 Rep. Ser., B. Zool.-Bot. 7: 149 (1948). — *Omphalodiscus subcerebriformis* (Dodge) Dodge, Bull. Jard. bot. Etat. Brux. 32: 302 (1962). TYPE: "George V Land, Cape Denison, J.G. Hunter, A.A.E. 70.". HOLOTYPE: (n.v.).

*Omphalodiscus decussatus* var. *tortuosus* Llano, J. Wash. Acad. Sci. 46: 185 (1956). TYPE: "Antarctica: MacRobertson Land, A.N.A.R.E. Base Mawson (lat. 67° 36′ 21″S., long 62° 52′ 48″E.). Leg. R.O. Summers, January 1955.". HOLOTYPE: (n.v.) (Llano p.185, does not state where the holotype material of this species has been lodged. A search of US (Hale, pers. comm.) and ABSL (Wetmore, pers. comm.) has failed to locate any type material, nor is there any specimen by this name amongst those collected by R.O. Summers held in MEL).

*Umbilicaria leiocarpa* var. *nana* Vainio, Exped. Antarct. Belge Res. voy. S.Y. Belgica Rap. Sci. Bot.: 9 (1903). — *Agyrophora leiocarpa* var. *nana* (Vainio) Llano, Monogr. Umbil.: 56 (1950). TYPE: "Détroit de Gerlache: sur un rocher isolé au milieu d'un glacier, à 300 m. d'altitude au-dessus du niveau de la mer, à l'Ile Brabant, 64° 21′ de latitude sud (10e debarquement, n. 250).". LECTOTYPE (here chosen): "Exped. Antarct. Belge 1898 250. Herb. Vainio 200 (Tur! 00554). ISOLECTOTYPE: "Expd Antart Belge 1897-99 no 250." (BR!).

*Dermatiscum mawsoni* Dodge, B.A.N.Z. Antarct. Exped. 1929-31 Rep. Ser., B. Zool.-Bot. 7: 152 (1948). TYPE: "King George V Land, Cape Denison, B.A.N.Z.A.R.E. 536.". LECTOTYPE (here chosen): "King George V Land (Antarctica) On rocks, Cape Denison, Commonwealth Bay 67° 00′S, 142° 36′E, 536-16. January 5, 6, 1931." (AD 12682!).

*Thallus* foliose, monophyllous, sometimes several thalli grow together giving the appearance of being polyphyllous, variable in size, (5-)c.15(-50) mm diam; margins smooth, sometimes laciniate, varying in colour from light grey-olive, brown, grey to almost black; upper suface dull, areolate, pruinose, smooth to rugulose and deeply folded; rugi elevated into a fine reticulate pattern or broadly compressed into strongly formed ridges; lower surface dull, varying from pale pinkish-buff to brown to sooty-black, sometimes a mottling of several shades; erhizinate. *Apothecia*

rare, laminal, mostly towards the margins of the thallus, to 0.8 mm diam., sessile or shortly stipitate, constricted below, marginate; margins prominent, smooth to crenulate; disk black, gyrose sometimes fissured in the centre; hymenium to 50 μm tall, pale brown; subhymenium* brown; hypothecium dark brown; asci 30-33 x 12-16 μm *ascospores* 8 per ascus, simple, hyaline, ellipsoid, 8-9 x 5-6 μm.

DISTRIBUTION: Fig. 3c.

DISCUSSION:

*Umbilicaria decussata* is a ubiquitous lichen. Its variable thallus has given reason to many authors for erecting new taxa. The antarctic environment has provided the most diversity with seven segregates from *U. decussata* being described as new. Dodge (1973) cites these seven as present in Antarctica but does not accept that *U. decussata* occurs there. This species is very common in Australia where numerous forms, including many of these segregates, may occur on a single rock. I find it impossible to accept that there is any difference between the specimens growing in Australia and those in Antarctica.

Unfortunately the type specimens of *Umbilicaria rugosa, U. cerebriformis, U. pateriformis, U. hunteri* and *U. subcerebriformis* have not been available for study. However three of these names are represented in the National Herbarium of Victoria by specimens which have been determined by Dodge and are cited in his BANZARE report (Dodge 1948). They are:

1. *Umbilicaria hunteri* Dodge (Hunter 11-2). In discussing this specimen Dodge (1948: 148) says "Hunter 11-2 seems to be a young thallus of this species, the cortices being much thinner than the measurements given above, the thallus is smooth, tawny olive when moist and the medulla has the same structure as the other specimens cited." This specimen consists of a single, small, pale brown thallus. It is consistent with similar smooth pale brown thalli which are considered to be underdeveloped forms of *U. decussata* growing in sheltered habitats. I have observed these forms in the Australian alps and in north Greenland and I can see no reason to separate them from *U. decussata.*
2. *Umbilicaria cerebriformis* Dodge & Baker (A.A.E. 28-1). This specimen, determined as *Charcotia cerebriformis* (Dodge & Baker) Dodge and so cited in the BANZARE report, consists of fragments of several small, rugulose thalli. No apothecia of *Scutula* were present on any of the fragments, but there is one small developing apothecium which has the appearance of a young apothecium of *U. decussata.*
3. *Umbilicaria subcerebriformis* Dodge (A.A.E. 104-2). This specimen consists of fragments of several small thalli. They are mainly pale whitish-brown to brown fragments which are consistent with *U. decussata* growing under adverse conditions.

*Umbilicaria rugosa* Dodge & Baker and *U. pateriformis* Dodge & Baker are separated from *U. decussata* in the key given by Dodge & Baker (1938) by the colour of the upper surface. Although I have not seen specimens of *U. rugosa* and *U. pateriformis,* I do not consider that surface colour is a valid criterion on which to differentiate species. From my own observations, colour varies according to the habitat and degree of exposure.

The type of *Dermatiscum mawsoni* Dodge is cited as "King George V Land, Cape Denison, B.A.N.Z.A.R.E. 536." and at the end of the protologue Dodge says "On rocks with *Umbilicaria rugosa* and *Lecanora exsulans.* King George V Land, Cape Denison, B.A.N.Z.A.R.E. 536-16, 536-17, 536-19.". The collection number 536 occurs throughout the B.A.N.Z.A.R.E. report with other sub-numbers representing other species so it appears that this number alone cannot represent

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* terminology according to Frey 1936, Fig. 1.

the holotype collection. Only one collection, 536-16, is represented in the B.A.N.Z.A.R.E. collection at the State Herbarium of South Australia (AD). It is annotated by Dodge *"Dermatiscum Mawsoni, Umbilicaria rugosa, Lecanora exsulans."* So it seems pertinent to select the lectotype from this collection. Unfortunately the enclosed thalli are crushed to fragments — all of which appear to be *U. decussata*. I examined several of the larger fragments but could not detect the alga *Trentepohlia* or any filamentous algal threads in them. There are one or two almost complete thalli 7-8 mm diameter which resemble the protologue of *D. mawsoni* which I have selected as lectotype.

Øvstedal (1983a) examined the lower surface of the type material of *Umbilicaria leiocarpa* var. *nana* by Scanning Electron Microscope. He concluded that it was not possible to distinguish between the sample which he examined and young specimens of *U. decussata*.

One specimen collected on "Operation Tabarin No. 2505" at Scar Hills, Hope Bay, Trinity Peninsula, East Graham Land, on 25.ix.1945 by I.M. Lamb, is unusually rugose on the upper surface. This specimen is sterile and has the appearance of *U. hyperborea* (Ach.) Hoffm. Lamb in his notes on the specimen says "This unusually rugose form was seen only in this one place." In the absence of more material I prefer to include it as a rugose form of *U. decussata* rather than include it as the only collection of *U. hyperborea* from the Antarctic Continent.

**Umbilicaria propagulifera** (Vainio) Llano, Monogr. Umbil.: 162 (1950). *Gyrophora cylindrica* f. *propagulifera* Vainio, Exped. Antarct. Belge Res. voy. S.Y. Belgica Rap. Sci. Bot.: 10 (1903). — *Gyrophora propagulifera* (Vainio) Räsänen, Rev. Univ. Santiago 23: 195 (1937). TYPE: "Détroit de Gerlache: sur un rocher isolé au milieu d'un glacier, à 300 m. d'altitude au-dessus du niveau de la mer, 64° 21′ de latitude sud, Ile Brabant (10e débarquement, n. 248 pr.p., 154).". LECTOTYPE (here chosen): "Exped Antarct Belge 1897-99 No. 154." (BR!). ISOLECTOTYPE: "Détroit de Gerlache: sur un rocher isolé au milieu d'un glacier, á 300m. d'altitude au-dessus du niveau de la mer, 64° 21′ de latitude sud, Ile Brabant (10e debarquement, n. 154). 1898 M. Emile G. Racovitza. (TUR 000597!). REMAINING SYNTYPE: "Exped Antarct Belge 1897-99 no. 248 pp. (BR!).

*Thallus* foliose, polyphyllous, rarely monophyllous, to 5(-10) cm diam., often several thalli grow together to form rosettes; margins smooth, flexuose, crenate to incised, thickly beset with branched rhizines; upper surface dull, pruinose, grey-brown to grey to almost black, usually darker centrally shading to the margins, smooth, cracking with age, occasionally perforations develop along the cracks and rhizines grow through forming tufts on the upper surface, older specimens show some obscure reticulate ridging; lower surface pale pinkish-brown to dark brown, with a sparse to well-developed covering of rhizines; rhizines irregularly branched, rarely simple, dark brown to black, thickly covered with thallospores. *Apothecia* to 1 mm diam., at first plane, becoming gyrose, stipitate; *ascospores* not seen.

DISTRIBUTION: Fig. 3d.

DISCUSSION:

*Umbilicaria propagulifera* is common in eastern Antarctica and has been located at a few localities in the west. However it is an easily overlooked species and could have a wider range.

I have chosen the specimen in BR as lectotype merely because although small, it is larger than the isolectotype. Both specimens have obvious thallospores on the rhizines and lower surface.

I first considered this material should be referred to *U. cylindrica* a cosmopolitan species which is very common in alpine areas of Australia. However *U. propagulifera* has been shown (Topham *et al.* 1982, Seaward *et al.* 1983) to differ from *U. cylindrica* by the presence of thallospores on the lower surface and rhizines.

Only one fertile specimen has been seen in the collections from the Antarctic, "Dry habitat, north facing rock slopes, Galindez Island. 16. xii.1935 British Graham Land "Penola" Expedition 1934-37" (BM). This specimen has two apothecia, one plane, very immature and the other showing a few gyri, however neither were sectioned. The external appearance of the apothecia resemble those found on *U. propagulifera* from Australia.

**Umbilicaria rufidula** (Hue) Filson, comb. nov. *Charcotia rufidula* Hue, Bull. Soc. bot. Fr. ser. 4, 15: 17 (1915). — *Umbilicaria rufidula* Hue, Deux. Expéd. Antarct. Franç. 1908-10, Sci. nat., doc. sci.: 52 (1915) nom. inval. — Charcotia rufidula Hue, Deux. Expéd. Antarct. Franç. 1908-10, Sci. nat., doc. sci.: 185 (1915) nom. inval. TYPE: "Sur les rochers, Ile Booth-Wandel, 10, 15 et 23 novembre 1904". LECTOTYPE (here chosen): *"U. Dillenii* Hue, Lich. in Exped. antarct. française 1903-1905, p.13." (PC!).

*Umbilicaria antarctica* Frey & Lamb, Trans. Br. mycol. Soc. 22: 270 (1939). — *Omphalodiscus antarcticus* (Frey & Lamb) Llano, Monogr. Umbil.: 76 (1950). — *Gyrophora antarctica* (Frey & Lamb) Golubkova & Savicz, Nov. Syst. Vysshikh. Rast. 3: 258 (1966). TYPE: "Regio antarctica: South Orkneys, Signy Island, leg. A.G. Bennett, 1915.". HOLOTYPE: "Antarctica: South Orkneys, Signy Island, leg. A.G. Bennett, 1915." (BM!).

*Umbilicaria dillenii* var. *solida* Frey, Bericht Sweiz. Bot. Ges. 45: 217 (1936). — *Umbilicaria solida* (Frey) Llano, Monogr. Umbil.: 196 (1950). TYPE: "Süd-Orkney Inseln, 60° 13′ s. B. coll. Edgar Szumla 1904, F. Kurtz Herbarium argentinum Nr. 12. 935 in Herb. Berlin-Dahlen." LECTOTYPE (here chosen): "Süd-Orkney-Inseln 60° 43′ S.B. 44° 47′ W Grenwich. leg. Edgar Szumla 1904 — F. Kurtz. Herbarium argentinum no 12.935. ex Herb. Berlin." (BERN-Frey 6081!).

*Thallus* foliose, thick, brittle when dry, monophyllous, to 15 cm diam.; margins flexuose, sometimes revolute, lacerated and torn, sometimes appearing ragged; upper surface dull, pale creamy-buff to reddish-brown to brownish-grey, smooth, undulate to mildly wrinkled, sometimes with small perforations, through which rhizines project from the lower surface; lower surface black, thallospores thick and conspicuous; rhizines moderate to dense, thinning to a bare zone around the umbilicus (in old specimens the lower surface may be almost bare with only a zone of short stunted rhizines around the margins), simple or sparingly branched to strap-like; thallospores farinose, often thickly covering the whole rhizine but occasionally towards the tips they become bare, when dry the rhizines are mostly black but occasionally they are brownish-buff or buff with a ginger tinge. *Apothecia* rare, laminal, towards the margins of the upper surface, to 1.5 mm diam., sessile, constricted below sometimes with several rhizines emerging from the lower cortex; margin prominent, smooth to flexuose; disk black, smooth or with central sterile column; hymenium to 60 μm tall; subhymenium pale brown; hypothecium dark brown; asci 35-45 x 13-18 μm; paraphyses septate, branched, only slightly expanded at the apices; *ascospores* simple, hyaline, ellipsoid, 10-15 x 6-7 μm.

DISTRIBUTION: Fig. 3e.

DISCUSSION:

Hue (1915a; 1915b) prepared and published two papers almost at the same time, causing a difficult nomenclatural problem. In his report (1915a) of the lichens brought back from the second French Antarctic Expedition, he published on page 52 a good description of a new species under the name *Umbilicaria rufidula.* The description was from specimens parasitised by the fungus *Scutula*, and Hue mistakenly accepted the apothecia of this *Scutula* as those of the new species. These apothecia are 0.1-0.2 mm diam., black, immarginate, hemispheric; asci 25-37 x 13-23 μm; ascospores two-celled, hyaline, slightly pointed at each end 13-14 x 5-7 μm

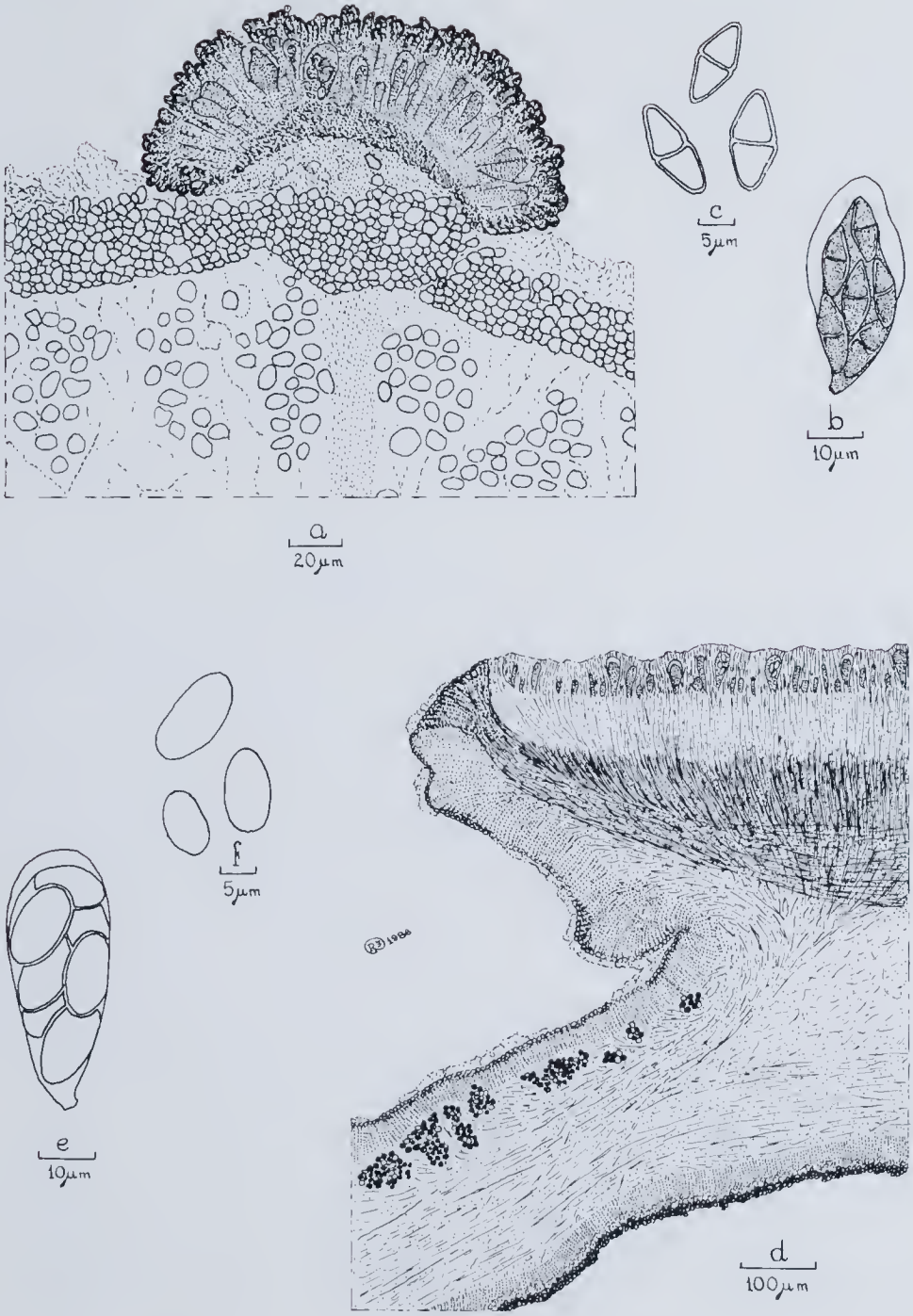


Fig. 2. a-c, *Scutula* sp., a — section through an apothecium; b — ascus; c — mature ascospores. d-f, *Umbilicaria rufidula*, d — section through an apothecium; e — a mature ascus; f — ascospores. a-c from the lectotype of *U. rufidula;* d-f from Lindsay 1190.

(Fig. 2 a-c). Subsequently he must have realised that the ascospores were not those of an *Umbilicaria* because on a later page, p. 185 of the same publication, he retained *U. rufidula* in the Umbilicariaceae but placed it in a new genus *Charcotia*, as *C. rufidula*. However in doing this, he gave no description of the new genus but merely stated "Charcotia Hue, Loco citato" "39. **Charcotia rufidula** Hue; *Umbilicaria rufidula* Hue", the "39" being a reference back to the species number placed against *Umbilicaria rufidula* on page 52.

*Charcotia* cannot be considered as validly published in the above report as it lacked a generic description (article 41.1, ICBN). Whether *Umbilicaria rufidula* is validly published in the report is questionable, although an adequate description on pages 52-54 accompanied the name. If the major part of Hue's report (including p. 52) and the final portion (including p. 185), which contained amendments to the earlier text, were published simultaneously then I believe that *Umbilicaria rufidula* Hue is not validly published as Hue himself did not accept this name in the publication (article 34.1a, ICBN). If, however, it could be shown that the report was published in parts and that p. 52 was issued before p. 185 then the name *Umbilicaria rufidula* Hue would be valid. Information given in the next paragraph indicates that text may have been typeset and proofed in stages but the printing layout of the publication supports the view that all pages of the finished publication appeared simultaneously and I have no evidence of any issue in parts.

Hue's second paper (1915b) appeared in the Bulletin Société botanique de France. On page 17 of this he published the "Genus CHARCOTIA Hue; gen. nov." giving a generic description and under this citing "Ch. RUFIDULA Hue; *Umbilicaria rufidula* Hue, *loc. citat.*, p. 52". There is no statement of what "*loc. citat.*" refers to, but from the page number 52 it is evident that Hue was referring to his report (1915a). He must therefore have had at least the page proofs of the report, or of portion of it, in hand at the time that he described *Charcotia* validly in the Bulletin. The citation above shows that *Charcotia rufidula* Hue was also validly published (article 32.1 c, ICBN) in this Bulletin paper.

Because the epithet *rufidula* was validly published in 1915, whether as *Charcotia* in Hue (1915b) or improbably as *Umbilicaria* in Hue (1915a), it predates all other valid epithets for this taxon and must have priority. I have therefore made a new combination to ensure that the epithet is unquestionably validated within *Umbilicaria*.

In the protologue of this species Hue placed under *U. rufidula* not only certain collections from the second expedition but also the specimens which he had incorrectly identified as *U. dillenii* Tuck. in his earlier paper (Hue 1908) enumerating the lichens of the First French Antarctic Expedition. I have therefore chosen the lectotype from the specimens collected on the First French Antarctic Expedition. The lectotype collection, from the Booth-Wandel Island in Marguerite Bay, consists of fragments of two thalli. One is large, typical, mummy-brown in colour, lightly parasitised with *Scutula*. I have chosen this thallus as lectotype. The other thallus is at a later stage of development, being pale and weathered and more fragmented and, although referrable to *U. rufidula,* differs too much from the lectotype to be considered an isolectotype.

I have discussed the type specimen of *U. antarctica* elsewhere (Filson 1975b). The lectotype specimen of *U. dillenii* var. *solida* Frey consists of two small fragments. This material was retained by Frey but the rest of the specimen probably was destroyed in Berlin in 1943 (Pilger 1953). The fragments are from a typical smooth-surfaced, mummy-brown thallus. The smallest fragment is lightly perforated with a few rhizines showing through to the upper surface.

Lindsay (1969) says that "no fertile material was found in the collections. Many thalli from the South Orkney and South Shetland Islands were parasitised by a species of *Scutula*.". However Lindsay 1190 and 1282 were both abundantly fertile with apothecia of *Umbilicaria* (Fig. 2 d-f).

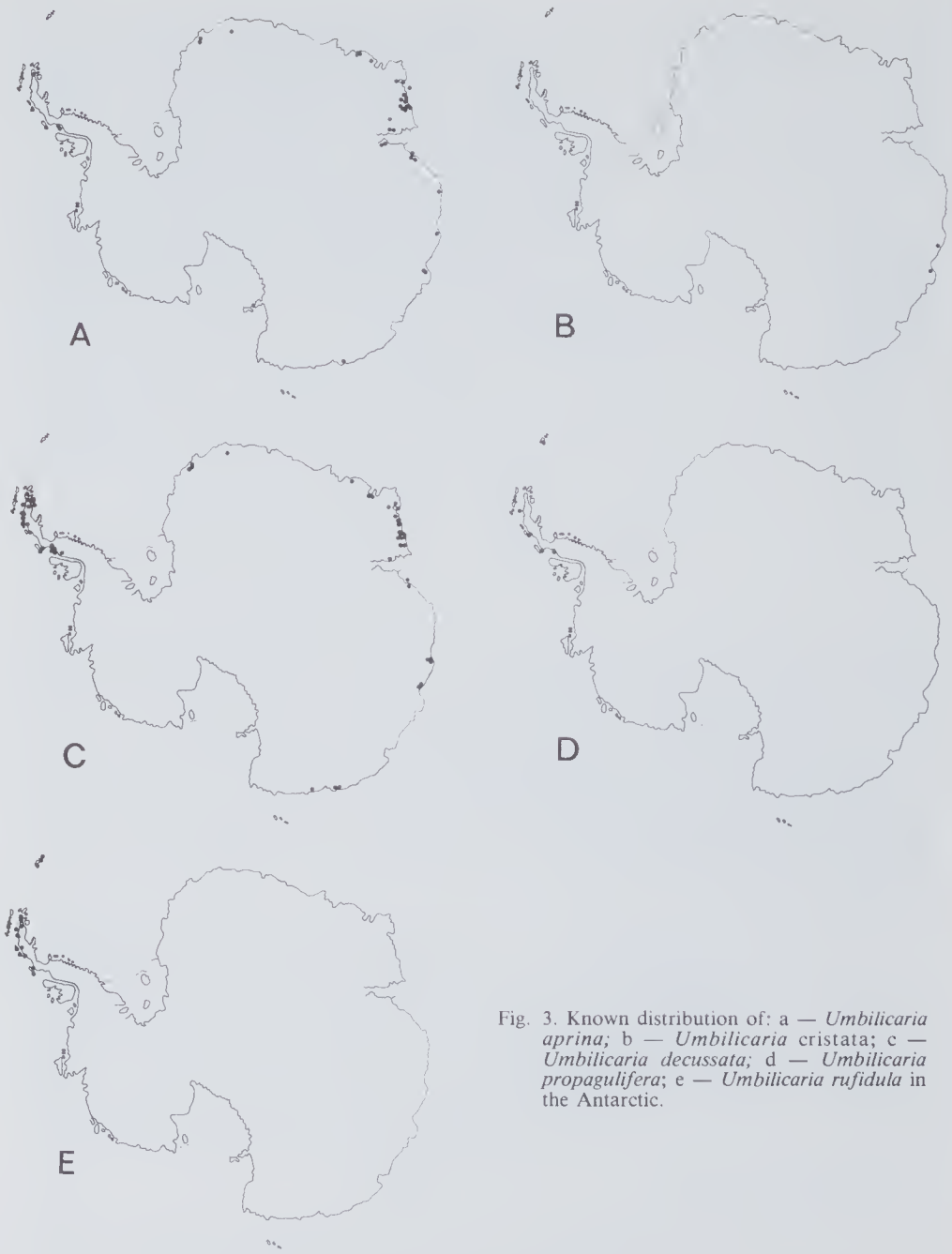


Fig. 3. Known distribution of: a — *Umbilicaria aprina;* b — *Umbilicaria* cristata; c — *Umbilicaria decussata;* d — *Umbilicaria propagulifera*; e — *Umbilicaria rufidula* in the Antarctic.

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London, England (BM) and Dr Carroll Dodge for the loan of type specimens. I am also grateful to the National Science Museum. Tokyo, Japan (TNS); the British Museum (Natural History), London, and the British Antarctic Survey, Cambridge, England (BAS), for the loan of modern collections.

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Manuscript received 29 September 1986.

# A REVISION OF BLENNOSPORA A. Gray (COMPOSITAE: INULEAE: GNAPHALIINAE).

by

P. S. SHORT*

## ABSTRACT

Short, P. S. A revision of *Blennospora* A. Gray (Compositae: Inuleae: Gnaphaliinae). *Muelleria* 6(5): 349-358 (1987). The endemic Australian genus *Blennospora* A. Gray is revised. Two species, *B. drummondii* A. Gray and *B. phlegmatocarpa* (Diels) P. Short are recognised. The genus is compared with *Calocephalus* R. Br. *s. str.* Lectotypes are chosen for the names *B. drummondii, Calocephalus phlegmatocarpus* Diels and *C. stowardii* S. Moore.

## INTRODUCTION

In a previous publication (Short 1981a) I suggested that *Calocephalus* R. Br., as defined by Bentham (1867) is a most unnatural genus and that *Blennospora* A. Gray, considered by Bentham to be synonymous with *Calocephalus,* should be reinstated. It was noted that *Blennospora* differed from *Calocephalus s. str.* "by a number of characters, i.e. pappus type, morphology and arrangement of bracts and cypsela morphology" (Short l.e., p. 401). The reinstatement of *Blennospora* has been accepted by Grieve (1982) and in post-1981 checklists of the plants of Western Australia, South Australia and Victoria. I (Short 1986) have also upheld it in the most recent edition of the 'Flora of South Australia'. The present paper details the reasons why I consider *Blennospora* and *Calocephalus* to be distinct.

*Calocephalus* was described by Brown in 1817. He failed to name any species, this task being left to Lessing (1832) who recognised two species, *C. citreus* Less. and *C. lacteus* Less. Bentham (1867) placed four genera, i.e. *Achrysum* A. Gray, *Blennospora, Leucophyta* R. Br. and *Pachysurus* Steetz, in synonymy. My revision of *Calocephalus s. lat.,* a genus considered by Bentham to consist of ten species, is still to be finalised. However it is clear that *Calocephalus s. str.* should be considered to be ditypic. Thus the characteristics of *Blennospora* are compared only with *C. citreus* and *C. lacteus.*

## METHODS

The methods used to determine pollen-ovule ratios and the measurements used to determine total anther length, the length of the microsporangia and the terminal anther appendage are the same as those used in a previous publication (Short 1985).

Fruit sections were obtained following the fixation of mature fruit with 5% glutaraldehyde in Pipes buffer and the subsequent infiltration and embedding in Spurr's resin (O'Brien & McCully 1981). Sections were stained in either Toluidine Blue, Aniline Blue Black or Coomassie Brilliant Blue.

To assist in the identification of vascular bundles fruits were cleared and stained in a solution of 1% Basic Fuchsin in 10% KOH (Wilcox 1977).

## RESULTS

Pollen-ovule ratios and anther measurements are summarised in Table 1. Except for the addition of data from *Short 1598* and *Short 1680* for *B. drummondii* all data come from populations previously specified in Short (1981a,b).

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Fruit differences between *Calocephalus* and *Blennospora* are illustrated in Figures 2-4 and are outlined in Table 2. Note that the carpopodium, a special structure which develops at the base of the fruit and is believed to facilitate separation of the fruit from the pedicel (Haque and Godward 1984) is only developed in *Blennospora* (Fig. 2b). It is absent from both *C. citreus* (Fig. 2e) and *C. lacteus*. The illustrations (Figs 2c,e) of the fruit of the latter species display part of the pedicel or stipe. All species of *Blennospora* and *Calocephalus* display a layer of endosperm which is one cell wide and all have crystals in the testa.

Table 1. Pollen-ovule ratios and anther characteristics of species of *Blennospora*.

| Characteristic | Species | $\bar{x}$ | S.D. | S.E.$\bar{x}$ | Range | n | Number of Populations |
|---|---|---|---|---|---|---|---|
| Pollen grains per floret (P/O) | B. phlegmatocarpa | 4,119.7 | 762.4 | 113.6 | 2,525-6,119 | 45 | 3 |
| | B. drummondii | 217 | 60.1 | 6.1 | 64-339 | 95 | 7 |
| Total anther length (mm) | B. phlegmatocarpa | 1.18 | 0.099 | 0.016 | 0.9-1.33 | 32 | 3 |
| | B. drummondii | 0.61 | 0.07 | 0.007 | 0.45-0.75 | 82 | 7 |
| Length of microsporangia (mm) | B. phlegmatocarpa | 0.91 | 0.084 | 0.014 | 0.68-1.06 | 32 | 3 |
| | B. drummondii | 0.32 | 0.39 | 0.004 | 0.22-0.42 | 82 | 7 |
| Length of terminal anther appendage (mm) | B. phlegmatocarpa | 0.27 | 0.04 | 0.007 | 0.23-0.38 | 32 | 3 |
| | B. drummondii | 0.28 | 0.054 | 0.006 | 0.15-0.42 | 82 | 7 |

Table 2. Characteristics of *Blennospora* and *Calocephalus s. str.*

| *Blennospora* | *Calocephalus s. str.* |
|---|---|
| Annual herbs. | Perennial herbs. |
| Leaves mainly alternate but sometimes the lowest pair opposite. | Leaves entirely opposite or sometimes the uppermost alternate. |
| Compound heads (inflorescence) each with (2)5-25(c. 30) capitula. | Compound heads each with c. 20-300 capitula. |
| General receptacle ill-defined, with shortly pedunculate capitula scattered along a stem-like axis. | General receptacle cylindrical to narrowly oblong, the capitula ± evenly distributed along the axis. |
| Capitular bracts:<br>— some shortly ciliate or with long hairs on the mid to upper margins.<br>— upper part not coloured and opaque.<br>— 8-10, in ± 2 rows. | Capitular bracts:<br>— all lacking marginal hairs.<br>— upper part opaque, white or yellow.<br>— 8-16, in 2 or ± 3 rows. |
| Florets 1-3 per capitulum. | Florets 2-3 per capitulum. |
| Cypselas:<br>— mucilaginous cells covering entire surface.<br>— pericarp with an inner layer of sclerenchyma.<br>— vascular bundles in pericarp medial to the cotyledons.<br>— carpopodium present, annular.<br>— stylophore distinct in mature fruit. | Cypselas:<br>— vesicular trichomes scattered over the surface.<br>— pericarp lacking inner layer of sclerenchyma.<br>— vascular bundles in pericarp oblique to the cotyledons.<br>— carpopodium absent.<br>— stylophore absent in mature fruit. |
| Pappus:<br>— of 7-10 irregularly long-ciliate bristles which are united at the base to form an irregular cup.<br>— bristles ¼ to about the length of the corolla tube. | Pappus:<br>— of 4-11 bristles which are plumose in the upper part and united at the base to form a small ring.<br>— bristles about the length of the corolla tube. |

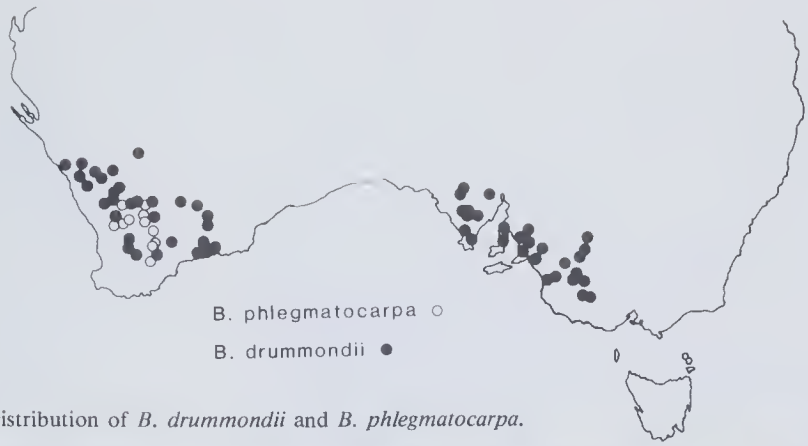


Fig. 1. Distribution of *B. drummondii* and *B. phlegmatocarpa.*

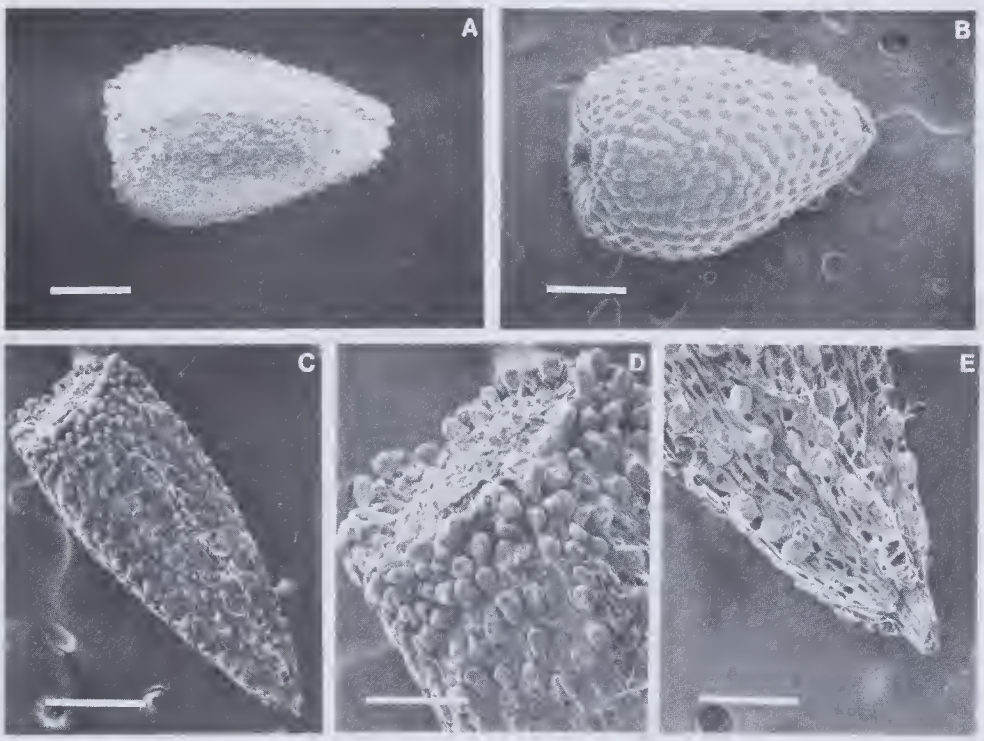


Fig. 2. Surface features of the fruit of *Blennospora* and *Calocephalus.* a — *C. citreus,* general view of entire fruit (*Short 855*). b — *B. phlegmatocarpa,* general view of entire fruit, note carpopodium & stylophore (*Short 1077*). c,d,e — *C. lacteus,* general view of entire fruit, apex & base respectively (*Opie & van Berkel 29*). Scales: a-c, 250 μm; d & e, 100 μm.

## DISCUSSION

### Generic Characteristics and Affinities

In a future paper I will be outlining my rationale for determining generic limits, emphasising the importance of having a number of complex character differences between species groups. In this respect *Blennospora* differs markedly from *Calocephalus* (see Table 2).

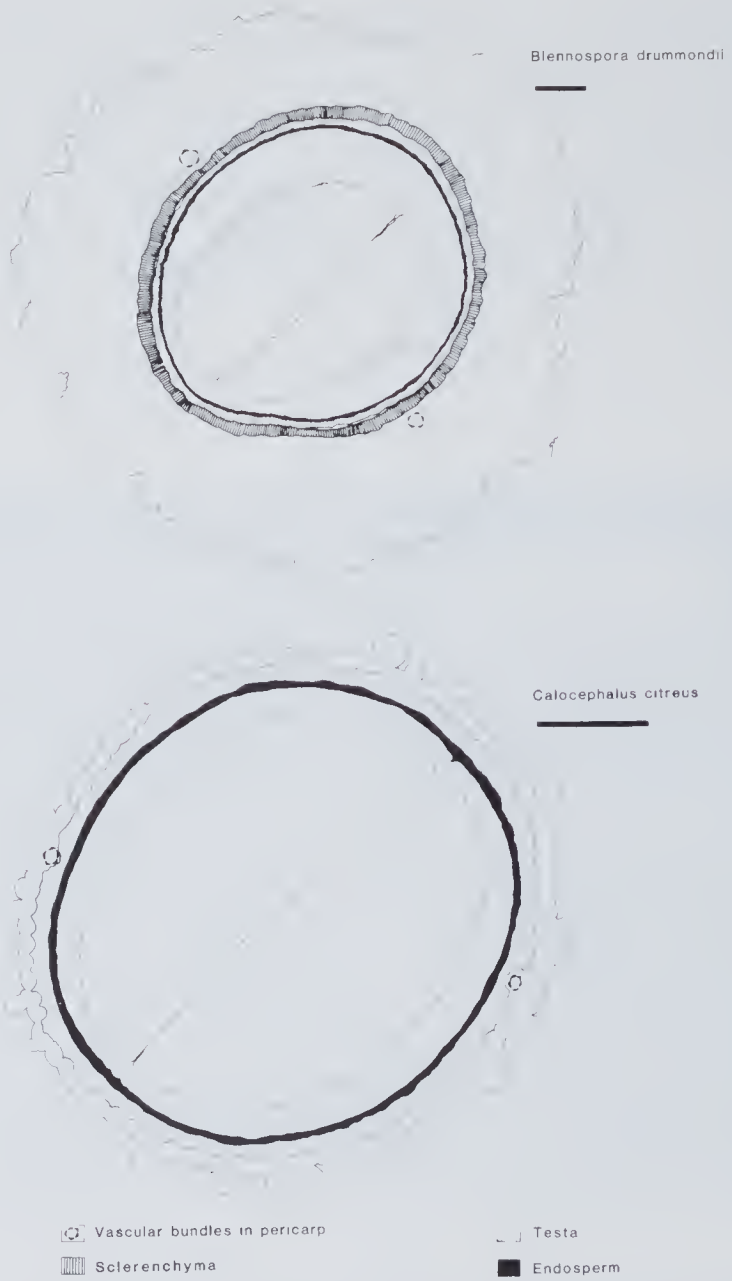


Fig. 3. Transverse sections of fruit of *B. drummondii* (*Short 1030*) and *C. citreus* (*Short 855*), diagrammatic. Both scales 100 $\mu$m.

Apart from the obvious differences in features such as habit and the morphology and arrangement of the capitular bracts one of the major characteristics by which the genera can be distinguished is fruit anatomy and morphology (Table 2, Figs. 2-4), a feature at this stage rarely used to distinguish genera of Australian Inuleae. The work by Kroner (1980) on *Athrixia* Ker-Gawler *s. lat.*, in which

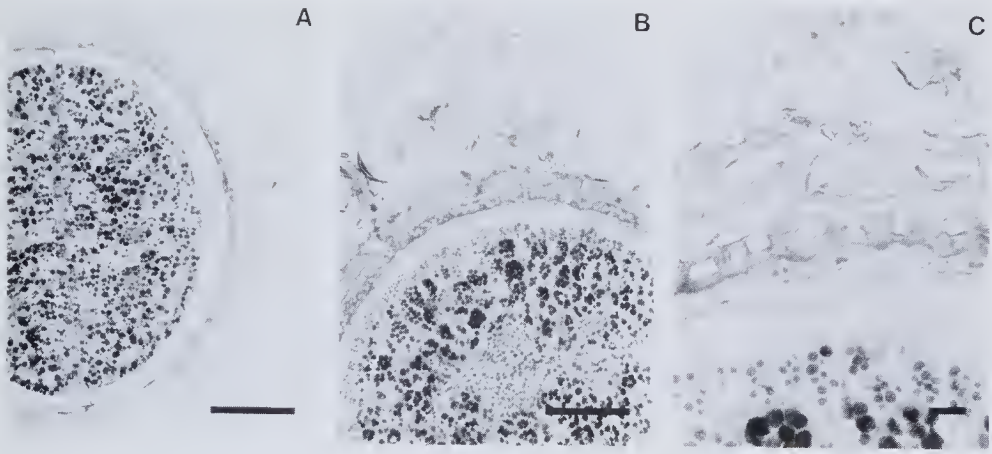


Fig. 4. Transverse sections of fruits. a — *C. citreus* (*Short 865*). b & c — *B. drummondii* (*Short 1030*). Scales: a & b, 100 μm; c, 10 μm.

features of the fruit are highlighted, is exceptional in this regard. Unpublished work on the fruit anatomy of *Angianthus s. lat.* and other members of the "*Angianthus* group" (Merxmuller *et al.* 1977, see Short 1983 for comments on this group) suggest that the fruit characteristics will prove to be of much use for the determination of generic limits in the Australian Inuleae.

The affinities of *Blennospora* are somewhat obscure but if pappus type and fruit morphology are a reliable guide then it would appear that they lie with various species currently included in *Helipterum* DC. Mr Paul G. Wilson (in litt., 1985) has suggested that the genus *Hyalosperma* Steetz, regarded as a synonym of *Helipterum* by Bentham (1867), is closely related.

**Reproductive Biology and Evolution**

The use of pollen:ovule ratios (P/Os) in the determination of plant breeding systems has previously been discussed for species of Inuleae, including the two species of *Blennospora* (Short 1981a,b). As noted, the high average P/O value (4,119.7, see Table 1) for *B. phlegmatocarpa* suggests that the species is an outbreeder (i.e. cross-fertilization is common) compared to *B. drummondii* which, with a P/O value of 217 (previously determined as 231 but additional populations have been sampled) is deemed to be an inbreeder (i.e. self-fertilization is predominant). This conclusion is supported by a number of other attributes. Thus *B. phlegmatocarpa* has yellow, pentamerous florets and a strong, somewhat putrid odour. In contrast *B. drummondii* has purplish-black pentamerous or occasionally tetramerous florets which emit a very weak odour. The position of the style arms in relation to dehiscent anthers has also been examined, suggesting that *B. phlegmatocarpa* is protandrous and *B. drummondii* possibly protogynous. Anther length also differs (Table 1) between species and as found for species of *Actinobole* (Short 1985) this primarily reflects a change in the length of the microsporangium, the terminal anther appendage being about the same length in both species. The alignment of pollen grains in the microsporangia also suggests that the anthers are tetrasporangiate in *B. phlegmatocarpa,* bisporangiate in *B. drummondii.*

Both species have a haploid chromosome number of n = 11.

Given that inbreeding is a derived characteristic then the distribution patterns of related outbreeding and inbreeding species can provide a clue as to the centre of origin and the direction of spread of taxa. Thus as previously argued (Short 1981a, b) it appears that *B. drummondii* may have originated in Western Australia and subsequently spread to the east.

## TAXONOMY

**Blennospora** A. Gray, Hook. J. Bot. Kew Gard. Misc. 3:98, 172 (1851); Short, Muelleria 4:401 (1981); Grieve, W. Aust. Wildfls Suppl. 4:72 (1982); Short, Fl. S. Aust. 3:1500 (1986). TYPE: *B. drummondii* A. Gray.

[*Calocephalus* auct. non. R. Br. (1817): Benth., Fl. Austr. 3:573 (1867); Benth. in Benth. & Hook.f., Genera Pl. 2:320 (1873); O. Hoffm. in Engl. & Prantl., Natürl. Pflanzenfam. 4(5):194 (1890); J. M. Black, Fl. S. Aust. 1st ed. 647 (1929), 2nd ed. 927 (1957); Willis, Handb. Pl. Vict. 2:731 (1973); Grieve & Blackall, W. Aust. Wildfls 773, 820 (1975).]

*Annual herbs.* Major axes ascending to erect, cottony hairy; stem often simple but commonly forming major branches at basal and/or upper nodes. *Leaves* mainly alternate but the lowest pair(s) opposite, all leaves sessile, entire, erect, mucronate, cottony hairy, often the uppermost ones with hyaline apices and merging with the bracts of the general involucre. *Inflorescence* a compound head, ellipsoid to broadly ellipsoid or ovoid to broadly ovoid; general involucre inconspicuous, the bracts ± leaf-like or ± resembling the capitular bracts. *General receptable* ill-defined, with shortly pedunculate capitula scattered along a stem-like, hairy axis. *Capitula* (2)5-25(30+) per compound head. *Capitular bracts* 8-10, in ± 2 rows. Outer 4-5 capitular bracts ± obovate to oblanceolate or spathulate or ± elliptic, each usually predominantly hyaline except for an opaque, green midrib extending for ⅔-¾ of its length but sometimes the hyaline margins poorly developed; bracts flat to conduplicate, glabrous on the inner surface but the outer surface often with long hairs at or about the apex of the midrib, the mid to upper hyaline margins shortly ciliate or with long hairs, the bracts united by the hairs. Inner 4-5 capitular bracts ± elliptic or ovate to lanceolate, each flat to conduplicate, predominantly hyaline except for an opaque green midrib extending for c. ½-⅔ its length, glabrous on the inner surface but the outer surface with long hairs at or about the apex of the midrib; margin entire or the mid to upper portions ciliate or with long hairs, the bracts free or united by the hairs. *Florets* 1-3 per capitulum; corolla tubular, (4)5-lobed, tube yellow, lobes purplish black or yellow. *Style* branches truncate, with short sweeping hairs. *Stamens* (4)5; anthers with a sterile apical appendage which is ± narrowly triangular; microsporangia tailed, endothecial tissue polarized; filament collar ± straight in outline and composed of ± uniform cells and basally not thicker than the filament. *Cypselas* homomorphic, ± obovoid; pericarp with mucilaginous cells covering the surface, with an inner layer of sclerenchyma (one cell thick), vascular bundles 2 and lateral to the cotyledons; testa containing crystals; carpopodium present, annular. *Pappus* of 7-10, multiseriate, flexible, irregularly long-ciliate bristles; bristles from ¼ to about the length of the corolla tube, forming an irregular cup at the base.

Chromosome number: x = 11 (Short 1981).

DISTRIBUTION (Fig. 1):

Both species recognised are found in Western Australia but *B. drummondii* extends to South Australia and Victoria.

### KEY TO THE SPECIES OF BLENNOSPORA

1. Lobes of florets yellow ..... 1. *B. phlegmatocarpa*
1. Lobes of florets purplish black ..... 2. *B. drummondii*

1. **Blennospora phlegmatocarpa** (Diels) P. Short, Muelleria 4:413 (1981); Grieve, W. Aust. Wildfls Suppl. 4:72 (1982). — *Calocephalus phlegmatocarpus* Diels, Bot. Jb. 35:614, fig. 69 o-u (1904); Grieve & Blackall, W. Aust. Wildfls 821 (1975). TYPE: "Hab. in distr. Avon pr. Wyola in lutosis gregaria flor. m. Oct. (D. 5020)". LECTOTYPE (here designated): *Diels 5020,* W. Australien: Wyola, 24.x.1901 (MEL 543205). PROBABLE ISOLECTOTYPE: *Diels s.n.,* East of York, s. dat. (PERTH).

*Calocephalus stowardii* S. Moore, J. Linn. Soc. Bot. 45:182 (1920); Grieve & Blackall, W. Aust. Wildfls 820 (1975). TYPE: "Cowcowing; *Stoward,* 485". LECTOTYPE (here designated): *Stoward 485,* West Australia, Cowcowing, 1916 (BM).

*Annual herbs* c. 1.5-10 cm high. *Leaves* semi-terete to ± terete or ± linear to narrowly oblanceolate, often ± succulent, held erect, 0.5-2.5(2.7) cm long, 0.05-0.15 cm wide, mucronate, cottony hairy, the uppermost ones with hyaline apices and merging with the bracts of the general involucre. *Inflorescence* ellipsoid to broadly ellipsoid or ovoid to broadly ovoid, 0.6-1 cm high, 0.45-1 cm diam.; general involucre inconspicuous, the bracts leaf-like or ± resembling the capitular bracts. *Capitula* c. 5-20 per inflorescence. *Capitular bracts* in ± 2 rows. Outer capitular bracts obovate to oblanceolate or ± elliptic, 1.7-2.9(3.2) mm long, 0.4-1.7 mm wide, each bract usually hyaline except for an opaque green midrib extending for ⅔-¾ of its length but sometimes the hyaline margins poorly developed; bracts flat to conduplicate, glabrous on the inner surface but the outer surface often with long hairs at or about the apex of the midrib, the bracts united by long hairs along the mid and upper margins. Inner capitular bracts ± elliptic or ovate, flat to conduplicate, 2.3-2.8 mm long, 1-1.5 mm wide, each predominantly hyaline except for an opaque green midrib extending for c. ½-⅔ its length, glabrous on the inner surface but the outer surface with long hairs at or about the apex of the midrib, the bracts with an entire margin or the mid to upper margin with long hairs which usually unite the bracts. *Florets* 1-3 per capitulum; corolla tube 1.5-2.4 mm long, with 5 yellow lobes. *Stamens* 5; anthers 0.9-1.33 mm long, each with a sterile apical appendage which is ± narrowly triangular and 0.23-0.38 mm long; microsporangia 0.68-1.06 mm long. *Cypselas* ± obovoid, 0.9-1.1 mm long, 0.6-0.8 mm diam. *Pappus* of 6-10 bristles, from c. ¼ to equal to the length of the corolla tube.

Chromosome number: 2n = 22 (*Short 633;* Short 1981b).

TYPIFICATION:

Stafleu & Cowan (1976) suggest that the Diels herbarium and types are in B, with Australian duplicates at BM, CANB and MEL. Enquiries reveal that the only extant, definite type material is at MEL, and it has been chosen as the lectotype. A duplicate collection probably exists in PERTH. It lacks a collector's number and date of collection but closely resembles the lectotype and the locality given, i.e. east of York, more or less agrees with the location of Wyola which is about 60 kilometres east-north-east of York.

The only type collection of *C. stowardii* located is at BM. It has been selected as the lectotoype because some unlocated duplicates may exist.

DISTRIBUTION (Fig. 1):

South-west region of Western Australia.

BIOLOGY:

Almost invariably restricted to saline, often sandy soils on the margins of salt lakes which comprise the Avon River System (Bettenay & Mulcahy 1972). Commonly associated with *Halosarcia, Atriplex* and *Disphyma* but may occur with *Melaleuca.* A few collections have been made from apparently non-saline soils in *Eucalyptus* woodland (e.g. *Short 654*).

SELECTED SPECIMENS EXAMINED (Total c. 30):

*Gardner s.n.,* Mortlock River flats, 2 miles E. from Meckering, 22.x.1945 (PERTH); *Haegi 2639 & Short,* Kevills Lake, 11.xi.1983 (MEL); *Short 619,* salty flats at base of Hines Hill, 21.ix.1977 (AD); *Short 633,* southern margins of Lake Brown, 22.ix.1977 (AD); *Short 679,* salt depression 1 km E. of Wave Rock, 25.ix.1977 (AD).

2. **Blennospora drummondii** A. Gray, Hook. J. Bot. Kew Gard. Misc. 3:173 (1851); Short, Muelleria 4:401 (1981); Grieve, W. Aust. Wildfls Suppl. 4:72 (1982); Short,

Fl. S. Aust. 3:1500 (1986). — *Calocephalus drummondii* (A. Gray) Benth., Fl. Austr. 3:574 (1867); J. M. Black, Fl. S. Aust. 1st ed. 648 (1929), 2nd ed. 928 (1957); J. H. Willis, Handb. Pl. Vict. 2:731 (1973); Grieve & Blackall, W. Aust. Wildfls 821 (1975). TYPE: "Swan River, *Drummond.*" LECTOTYPE (here designated): *Drummond s.n.*, Sw. riv., s. dat. (K). POSSIBLE ISOLECTOTYPES: *Drummond 359,* West Australia, s. dat. (BM, GH, MEL 543273, P — 2 sheets). REMAINING SYNTYPE AND ISOSYNTYPE: *Drummond 68,* Swan River, N. Holl., s. dat. (K, mounted with lectotype; E, ex herb. GL).

*Annual herbs* 1-10 cm high. Major axes ascending to erect, cottony hairy; stem often simple but commonly forming major branches at basal and/or upper nodes. *Leaves* semi-terete to ± terete or ± linear to narrowly oblanceolate, often ± succulent, held erect, 0.5-2.5 cm long, 0.05-0.1 cm wide, mucronate, cottony hairy, the uppermost leaves usually overtopping the inflorescence. *Inflorescence* ellipsoid to broadly ellipsoid or ovoid to broadly ovoid, 0.6-1.2 (c. 1.5) cm high, 0.4-1.3 cm diam.; general involucre inconspicuous, the bracts ± resembling the capitular bracts, mainly hyaline but with an opaque, green midrib, glabrous to densely hairy on the outer surface. *Capitula* (2)10-25(30+) per inflorescence. *Capitular bracts* in ± 2 rows. Outer capitular bracts obovate to spathulate, sometimes ± elliptic, 1.7-3(3.5) mm long, 0.7-1.2(1.5) mm wide, each usually hyaline except for an opaque green midrib extending for c. 2/3 its length but sometimes the hyaline margins poorly developed; bracts flat to conduplicate, the upper hyaline margins variably ciliate, glabrous on the inner surface but externally usually with long hairs at or about the apex of the midrib and the bracts united by the long hairs. Inner capitular bracts elliptic or ovate to lanceolate, (1.8)2.5-4 mm long, 1.7-3(3.5) mm wide, each predominantly hyaline but with an opaque green midrib extending for c. ⅔ its length, conduplicate, with entire or ciliate upper margins, glabrous on the inner surface but externally with long hairs at or about the apex of the midrib, the bracts free or united by the long hairs. *Florets* 1-3 per capitulum; corolla tube 1.8-2.2 mm long, with (4)5 purplish black lobes. *Stamens* (4)5; anthers 0.45-0.75 mm long, each with a sterile apical appendage which is ± narrowly triangular, 0.15-0.42 mm long, microsporangia 0.22-0.42 mm long. *Cypselas* ± obovoid, 1.1-1.4 mm long, 0.8-1.1 mm diam. *Pappus* of 7-8 bristles, from c. ⅓ to equal to the length of the corolla tube.

Chromosome number: 2n = 22 (*Short 595, 719;* Short 1981b).

TYPIFICATION:

Gray (1851) described *B. drummondii* from collections made by James Drummond in Western Australia and forwarded to Gray by Sir William Hooker. At K there is a single sheet containing two apparently different collections made by Drummond, i.e. *Drummond 68* and *Drummond s.n.*. Each collection consists of a single specimen, is accompanied by an envelope containing fragments, and is annotated 'Blennospora Drummondii n. gen.' in Gray's hand. I have chosen the unnumbered collection as the lectotype. The collections in BM, GH and MEL of *Drummond 359,* none of which are annotated by Gray, all bear a strong resemblance to the lectotype.

Of the two sheets of *Drummond 359* in P, one is annotated by Gray as 'Blennospora n. gen.' and consists of two specimens. This sheet was not selected as the lectotype as the lack of a specific epithet suggests to me that Gray may not have closely examined the collection, perhaps only annotating it after general sorting of material when visiting Paris during his journey to Europe from June 1850 to August 1851 (Farlow 1888). As with other specimens of *Drummond 359,* the ones in P closely resemble the lectotype specimen.

DISTRIBUTION (Fig. 1):

South west region of Western Australia, southern South Australia and western Victoria.

ECOLOGY:

Found in an array of habitats. Collectors' notes include "Shallow red-brown sandy loam over limestone. Mallee scrub.", "On sand dune associated with *Eucalyptus incrassata, Triodia* & various small annuals.", "Sandy loam at base of granite [rock], with moss.", "Growing in brown loam amongst *Eucalyptus, Acacia* shrubs and extending into *Arthrocnemum* [=*Halosarcia*] zone around salt lake.", "In open *Eucalyptus* woodland on brown sandy loam." and "Growing in open areas between low mallee eucalypts and *Melaleuca.* Sand to very sandy loam.".

The species probably has a lower tolerance to salinity than *B. phlegmatocarpa* with collections (e.g. *Short 1030*) rarely coming from the upper margins of the samphire zone surrounding saline depressions. This is the most common habitat of *B. phlegmatocarpa.*

SELECTED SPECIMENS EXAMINED (Total c. 230):

*Western Australia — Short 595,* c. 31 km E. of Dalwallinu, 19.ix.1977 (AD); *Short 683,* Purnta Rock, 26.ix.1977 (AD); *Short 1030,* c. 21 km N. of Wongan Hills, 20.xi.1979 (AD); *Short 1060,* c. 21 km N. of Kojonup, 23.xi.1979 (AD); *Short 1598,* 1.5 km W. of Ajana, 31.viii.1982 (MEL); *Short 1680,* W. edge of Lake King, 11.ix.1982 (MEL); *Wilson 8889,* 65 km SW. of Sandstone, 26.viii.1970 (PERTH).

*South Australia — Barker 842,* south side of Mickey Flat road, c. 1.5 miles west of the Ardrossan to Pt Vincent road, 12.x.1970 (AD); *Keane 106,* Rowland Flat, 29.ix.1978 (AD); *Short 719,* c. 6 km SW. of Pt. Julia, 17.xii.1977 (AD).

*Victoria — Corrick 6630* & *Short,* c. 6 km east of Underbool Tank, 30.ix. 1980 (MEL); *Short 1219 & Corrick,* c. 24 km SW. of Nhill, 4.x.1980 (AD).

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I thank Mr J. Nailon, Mrs R. McFarlane and Miss K. Wilson for the preparation of the SEM photographs, fruit sections and figures and Miss H. Aston for comments on the original manuscript.

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# NYMPHOIDES BEAGLENSIS (MENYANTHACEAE): A NEW AUSTRALIAN SPECIES

by

HELEN I. ASTON*

## ABSTRACT

Aston, Helen I. *Nymphoides beaglensis* (Menyanthacaeae): a new Australian species. *Muelleria* 6(5): 359-362 (1987). — *Nymphoides beaglensis* is described and its diagnostic features illustrated. The species is known only from the Beagle Bay area of the Kimberley region of Western Australia.

## TAXONOMY

This paper is the fourth precursor to a revision of *Nymphoides* Séguier in Australia. Descriptions of eight new species appeared in three previous papers (Aston 1982, 1984, 1986). Except for an extreme modification of the transverse fringe of each corolla lobe, the common characters given on page 35 of the first paper also apply to *N. beaglensis*. This species belongs in the "indica group" defined on the same page.

**Nymphoides beaglensis** H.I. Aston, sp. nov.

Laminae foliorum integrae, latissime ovatae ad ± rotundatae, profunde cordatae sino angusto, c. (20-)25-50 mm longae x c. 22 mm latae. Petiolus folii, quod inflorescentiam sustinet, conspicuus c. 1.5-7.5 mm longus, quam lamina paulo brevior ad fere duplo longior. Inflorescentia c. 7-17 pedicellorum vel dense aggregatorum vel per rhachim ad 18 mm longam approximatorum formata; nonnumquam 2-4 inflorescentiae contiguae una ut videtur. Flores heterostylosi, 5-partiti. Corolla c. 18-22 mm lata, alba vel alba subroseo-malvacea suffusa, atromarronino-malvacea in fauce; lobi corollae alis lateralibus latis, haud profunde laciniatis, praediti; glabri praeter duos conspicuos fasciculos caespitosos pedicellatos capillorum papillosorum, singulos in lateribus basi loborum; papillae tubi corollae simplices, breves, c. 0.3-0.8 mm longae, c. 50-70 aggregatae in fasciculo denso sessile vel subsessile, Capsula ellipsoidea ad late ellipsoidea, 3.5-6.0 mm longa. Semina c. 33-64 in capsula, paene globosa, minime ad modice utrinque compressa, 0.75-0.95 mm longa x 0.70-0.85 mm lata x 0.55-0.70 mm crassa, maturitate atrofumosa; pagina caespitibus tuberculorum 1-8 erectorum obtusorum, ad 0.5 mm longitudine vel dispersis vel solis, apud iuxtaque marginem; caruncula basalis circularis, pallida, crassa, conspicua.

*N. triangulari* H.I. Aston atque *N. elliptica* H.I. Aston et corollae colore et petiolo longo folii quod inflorescentiam sustinet similis; differt, tamen, praecipue in magnitudine sculpturaque seminis, in dispositione capillorum in lobis corollae, et in papillorum tubi corollae.

Apparently annual. *Petiole-like stems* few, arising from the plant base, slender, flexuose, 4-20 cm long x c. 0.8-2 mm diam.; true petiole of stem leaves conspicuous, c. 1.5-7.5 cm long, a little shorter than to almost twice as long as the blade, about equal in width to the stem and like it tinged or deeply coloured with maroon-purple. *Basal leaves* also present, their petioles few-30 cm long. *Leaf blades* floating, entire, very broadly ovate to ± circular in outline, deeply cordate with a narrow basal sinus; sinus c. 30-45% of total blade length, of c. 0°-30° angle or the lobes slightly overlapping; basal lobes obtuse to rounded; blade c. (20-)25-50 mm long x c. 22-47 mm wide, widest just above the level of petiole insertion, dark green above, paler green tinged with purple or entirely deep maroon-purple beneath, not spongy. *Inflorescence* as for the "indica group", the pedicels subtended by acute bracts c. 1-6 mm long and grouped c. 7-17 together in a cluster distanced from the subtending leaf blade by the conspicuous petiole; pedicels either tightly massed in each cluster or the rachis of the cluster extended to 18 mm long with the pedicels

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and their bracts spaced up to 3 mm apart along it; stems often bearing 2-4 close-spaced inflorescences only 2-7 mm apart so that both or all these inflorescences may appear as one, particularly when the subtending leaf develops only at the lower inflorescence. *Pedicels* very slender, 25-80 mm long x <0.5(-1) mm diam., green tinged with pale to deep maroon-purple. *Flowers* heterostylous, 5- partite. *Calyx lobes* lanceolate to narrowly ovate, acute, c. 4.8-6 mm long. *Corolla* c. 18-22 mm span, "white" (*Dann 70*) or white with the central sections of the lobes tinged pinkish-mauve and grading to deep maroon-mauve at the throat (*Kenneally 9451*). *Corolla lobes* broadly ovate to broadly obovate, emarginate; mid-section of lobe glabrous except for two conspicuous long-stalked tuft-like clusters of minutely papillate hairs positioned one on each side at the lobe base, each beside the insertion of the filament; hair clusters consisting of c. 10-22 hairs to 1.3 mm long on a stalk c. 0.2-1.1 mm long; side wings of lobe broad, undulate, shallowly laciniate (deeply so at the apex), extending from the apex almost to the lobe base. *Corolla tube* somewhat shorter than the calyx; tube papillae short, obtuse, c. 0.3-0.8 mm long, c. 50-70 together in a dense cluster, the cluster sessile or on a base of slightly raised tissue c. 1-1.5 mm long. *Stamens* with filaments c. 0.5 mm and c. 2.2 mm long in long-styled and short-styled flowers respectively; anthers broadly linear, 3-4 times as long as broad, 1.3-2 mm long. *Gynoecium (long-styled flower)* c. 6 mm or more long; ovary ellipsoid, gradually tapered into the style; placentas 2, about one third of the ovary length, positioned centrally down the ovary wall; ovules c. 45-77; style c. 2.3 mm long, slender; stigmas 2, each an erect laciniate wing (not fully examinable on material seen). *Gynoecium (short-styled flower)* c. 4.6-4.9 mm long; style c. 0.5-0.7 mm long; stigmas c. 1-1.4 mm long x 2.4-2.6 mm broad, strongly laciniate into numerous papillae, appearing brush-like. *Capsule* ellipsoid to broadly ellipsoid, ± equal to the calyx, 3.5-6 mm long. *Seeds* c. 33-64 per capsule; body of seed near-globose but slightly to moderately laterally compressed, 0.75-0.95 mm long x 0.70-0.85 mm wide x 0.55-0.70 mm thick, dark grey-brown-black when mature, the surface bearing spaced clusters of 1-8 erect obtuse tubercles to 0.5 mm long, or sometimes the faces smooth and the tubercle-clusters present only on and near the edges; basal caruncle circular, pale, very thick and conspicuous. Fig. 1.

TYPE COLLECTION:

8 km east of Beagle Bay Mission, Dampierland Peninsula, in permanent pool known locally as "Bunguaduk", 16° 58′ S., 122° 44′ E., Kimberley region, Western Australia, 20.viii.1985, *K.F. Kenneally 9451* (Holotype: PERTH. Isotype: MEL 1549338).

OTHER SPECIMENS EXAMINED:

*Western Australia (Kimberley region)* — Bungaduk Waterhole, 6.7 km E. of Beagle Bay Aboriginal Community, 16° 59′ S., 122° 40′ E., 24.vi.1984, *J.R. Dann 70* (PERTH). Beagle Bay, 16° 56′ S., 122° 45′ E., [22-24.iv.]1879, *A. Forrest s.n.* (MEL 1549339).

DISTRIBUTION:

*Western Australia* — Known only from a very restricted area east of Beagle Bay, Kimberley region, from the three collections cited above, two of which (probably all three) came from the same waterhole.

HABITAT:

Shallow fresh water or on mud at water's edge. Permanent waterhole or billabong. Fl. and Fr. recorded late April to late August.

NOTES:

Readily recognised as a member of the "indica group" by the white to pinkish-mauve flowers and the clustered inflorescence arising from the apparent petiole, although the frequent occurrence of inflorescences with extended rachises, and often the presence of close-spaced inflorescences with only one subtending leaf for all,

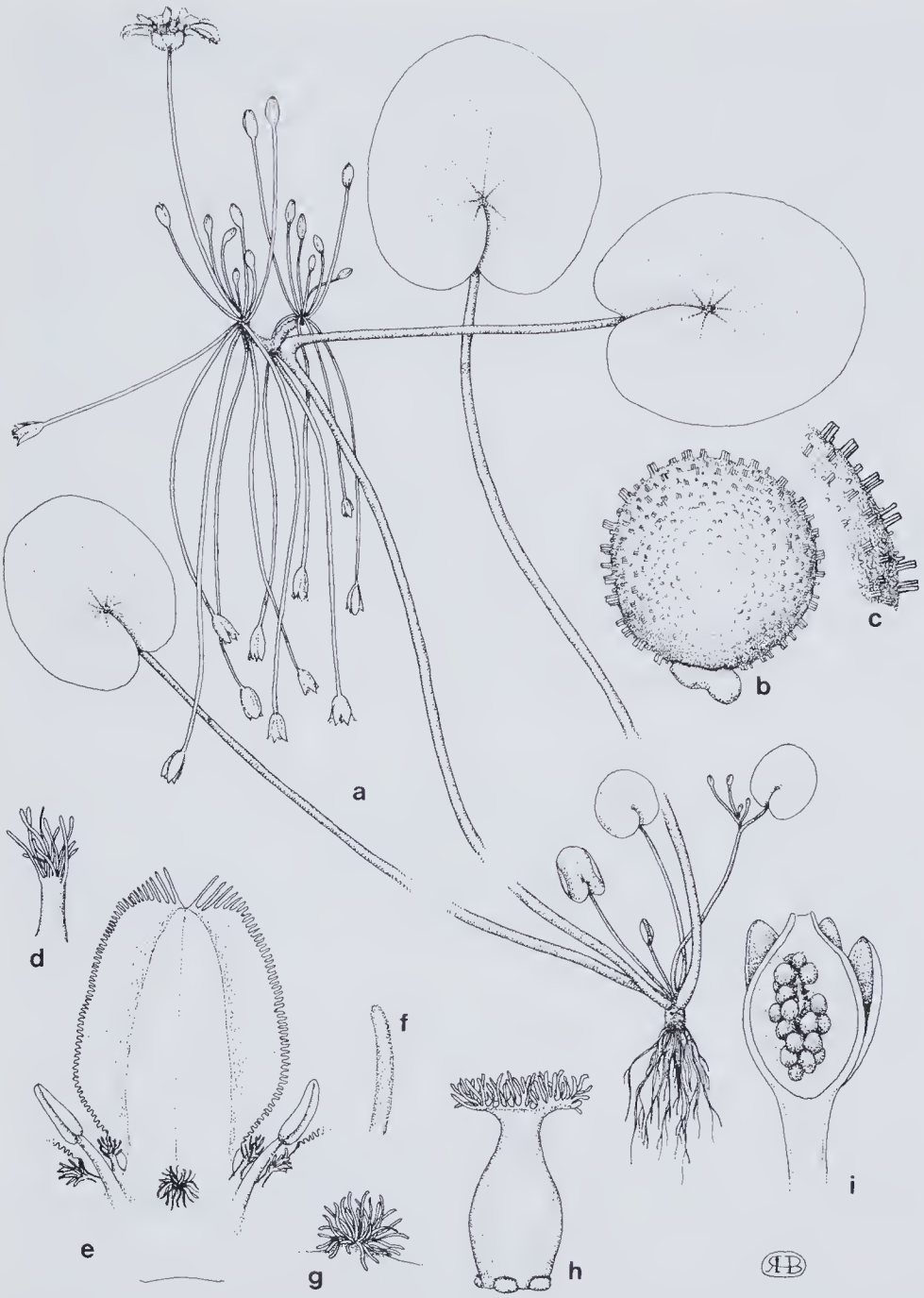


Fig. 1. *Nymphoides beaglensis.* a — habit, x 0.8. b — seed, lateral view, x 34. c — seed, enlargement of edge portion, x 68. d — stalked hair-cluster from lateral position at corolla lobe base, x 8. e — corolla, portion showing one lobe with its basal fringe represented only by two stalked lateral hair-clusters, one of the papilla clusters of the throat, and two stamens, x 5.5. f — papilla from a cluster of the corolla throat, x 25. g — papilla cluster from corolla throat, lateral view, x 8. h — gynoecium of short-styled flower, x 6. i — capsule, longitudinal section showing one of the placentas with seeds; some seeds removed, x 5. Lower rooting portion of habit from *Dann 70;* remainder of figure from *Kenneally 9451.*

are unusual for the group. *Nymphoides beaglensis* differs from all other species of the "indica group" in its ornamentation of the corolla lobes (the presence of distinctive stalked lateral hair clusters at the base being the only semblance of the transverse fringe of papillae found in other species) and in its seed characters. In the pinkish-mauve tinge to the corolla and in the long petiole of the inflorescence-subtending leaf, *N. beaglensis* most closely resembles *N. triangularis* H.I. Aston and *N. elliptica* H.I. Aston from Cape York Peninsula. However, the latter two species differ from *N. beaglensis* particularly in their seeds, in the complete fringe of papillae across the corolla lobe base, and in the papillae of the corolla tube consisting of fine branched hairs.

Examination of some flowers which had part-withered before placement in spirit, or which were softened by boiling, presented difficulties, but a flower from *Dann 70* and one from *Forrest s.n.* apparently had anthers held level with the stigmas and on filaments 1-1.5 mm long, i.e. intermediate in length to the measurements recorded in long-styled and short-styled flowers. They could represent a mid-styled condition and, if so, the species is tristylous.

As I have not seen this species in the field, information obtained from photographs and spirit material (PERTH 4821/B) accompanying the type collection and spirit material of *Dann 70* (PERTH 4535/B) has been particularly valuable in providing details of flower structure and in adding to the information obtainable from the dried sheets. The recent collections have enabled me to confirm my suspicion that the early collection of Forrest would prove to belong to an undescribed species.

The approximate day and the month of collection of *Forrest s.n.* has been determined from his journal (Forrest 1880).

The epithet *beaglensis* refers to Beagle Bay, near which the species is apparently endemic.

## ACKNOWLEDGEMENTS

I am particularly indebted to Mr K.F Kenneally, Western Australian Herbarium, for his care in obtaining dried, spirit and photographic material and supplying the type collection. My thanks are also extended to Dr G.A.M. Scott, Queens College, University of Melbourne, for preparation of the Latin description from an English draft and to Mr R.H. Barley, National Herbarium of Victoria, for providing the illustration.

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Manuscript received 25 August 1986.

# VARIATION IN EUSTREPHUS R. Br. ex Ker Gawler AND GEITONOPLESIUM Cunn. ex R. Br. (ASPARAGALES: LUZURIAGACEAE)

by

J. G. CONRAN*

## ABSTRACT

Conran, J. G. Variation in *Eustrephus* R. Br. ex Ker Gawler and *Geitonoplesium* Cunn. ex R. Br. (Asparagales: Luzuriagaceae). *Muelleria* 6(5): 363-369 (1987). — The variation of several characters within *Eustrephus latifolius* R. Br. ex Ker Gawler and *Geitonoplesium cymosum* (R. Br.) Cunn. ex R. Br. is studied and found to be continuous. Leaf width in *E. latifolius* and leaf size in *G. cymosum* are found to be clinal with latitude, the average leaf width and length for *G. cymosum* decreasing at higher latitudes and the average leaf width of *E. latifolius* increasing. None of the infraspecific taxa recognised by previous authors are maintained.

## INTRODUCTION

*Eustrephus* R. Br. ex Ker Gawler and *Geitonoplesium* Cunn. ex R. Br. are both monotypic genera in the Luzuriagaceae (Asparagales). They both vary from sub-shrubs to woody climbers, and have been variously included in the Liliaceae (Krause, 1930), Smilacaceae (Cronquist, 1981; Conran and Clifford, 1986), Philesiaceae (Dahlgren and Clifford, 1982) and Luzuriagaceae (Dahlgren *et al.*, 1985). Recent work by Conran (1985) suggests that they are related to the Luzuriagaceae and the Phormiaceae.

Both genera are predominantly eastern Australian, with *Eustrephus* extending to Lord Howe Island, New Caledonia and Papua New Guinea (Fig. 1a), whereas *Geitonoplesium* extends further to Norfolk Is., Fiji, the Solomon Islands and in Malesia to Java (Fig. 1b).

Schlittler (1951) monographed the two genera, providing detailed accounts of their morphology and anatomy in addition to their taxonomy. He recognised, within each species, two subspecies, two varieties, two subvarieties, two forms and two subforms. Examination of material of both genera in the field and under cultivation at Queensland University, and measurements of herbarium accessions suggest that the variants recognised by Schlittler (1951) intergrade and the distinction of infraspecific taxa is unjustified. In their treatment of the Australian Smilacaceae, Conran and Clifford (1986) accepted *Eustrephus* and *Geitonoplesium* as monospecific genera with no infraspecific taxa. This paper substantiates their conclusions in giving a critical assessment of the variation within the characters used by Schlittler to characterise his infraspecific taxa. The synonymies given by Conran and Clifford are amended accordingly.

## METHODS AND RESULTS

All specimens identified as *Eustrephus* and *Geitonoplesium* at BRI, BRIU, CANB, CBG, L, MEL and NSW were examined. 125 specimens each of *E. latifolius* R. Br. ex Ker Gawler and *G. cymosum* (R. Br.) Cunn. ex R. Br. from these herbaria were selected, and on each specimen ten leaves were measured for length and maximum width and the results averaged. Correlation coefficients between average leaf length and width, average length and latitude of collection, and average maximum width and latitude were calculated for both species. Scatter diagrams of leaf length against width were plotted for each species, with the specimens graded according to latitude of origin (Fig. 2).

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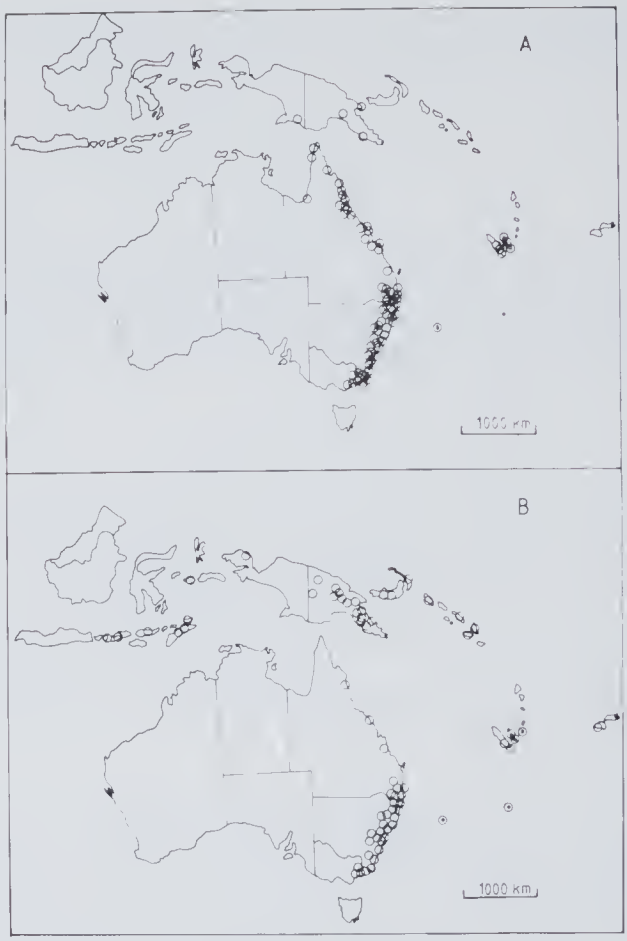


Fig. 1. Geographical distribution of specimens examined. a — Eustrephus latifolius. b — *Geitonoplesium cymosum*.

In *E. latifolius,* a significant positive correlation ($p \geq 0.01$) was found between average leaf width and latitude indicating that as latitude increases, the leaves become progressively broader (Fig. 2a). Leaf width was not, however, significantly correlated with average leaf length, so that the broadening of the leaves was not a result of an overall leaf size increase.

*Geitonoplesium cymosum,* however, showed a significant positive correlation between average leaf length and width ($p \geq 0.001$), as well as significant negative correlations ($p \geq 0.001$) between both leaf length and width, and latitude. This indicates that the leaves as a whole get smaller at higher latitudes (Fig. 2b).

In addition to the herbarium studies, 10 specimens each of *E. latifolius* and *G. cymosum* were cultivated from field-collected seed from south-east Queensland, under 80% shade in unheated shade frames at Brisbane, and at maturity were transferred to 30% shade. Leaf dimensions were recorded in both sets of conditions, and the same plants were found to produce broad leaves under low light and narrower leaves under high light. Cultivated specimens of the narrow-leaved forms produced broad leaves (c. 8-12mm wide) when grown under low light (c. 80% shade), while the same plants, transferred to 30% shading, produced leaves only 3-4 mm wide.

## TAXONOMIC DISCUSSION

### Eustrephus

In *E. latifolius,* the variation recognised by Schlittler (1951) consists of variation in leaf shape (subspecies), filament fusion (variety), number of flowers per inflorescence (subvariety), flower colour (form) and degree of tepal fimbriation (subform). Of these infraspecific taxa, only those based on leaf shape are recognised by authors other than Schlittler, although usually at the level of variety (Bailey, 1902; Jacobs and Pickard, 1981).

Schlittler recognised two subspecies: *E. latifolius* subsp. *angustifolius* (R. Br.) Schlittler and *E. latifolius* subsp. *watsonianus* (Miq.) Schlittler on the basis of leaf width. This study does not support such a division, as there is continuous clinal intergradation in leaf width as well as environmentally induced phenotypic variation. While it would be possible to recognise the extreme ends of the cline as subspecies, the majority of the specimens are intermediate in their leaf width, and there is no clear point in the continuum at which a realistic division on leaf width could be made (Fig. 2a).

The varieties recognised by Schlittler were *E. latifolius* var. *brownii* (F. Muell.) Schlittler with the staminal filaments fused into a tube, and *E. latifolius* var. *intermedius* Schlittler with free filaments. The latter taxon is typified by a collection from Batavia, apparently based on a cultivated or naturalised plant since, according to Backer and Backhuizen van den Brink (1968), the species is not native to Java. None of the specimens examined possessed free stamens, although the degree of fusion was variable. The recognition of these varieties does not appear to be warranted, especially when the only known example of free filaments is from a cultivated plant.

Schlittler recognised two subvarieties: *E. latifolius* subvar. *uniflorus* (H. Hallier) Schlittler with single-flowered inflorescences, and *E. latifolius* subvar. *fascicularis* Schlittler with several to numerous flowers. This condition, however, varies depending on the age and general condition of the plants, and individual branches on the same plant may vary considerably in the numbers of flowers produced (from 1-15). These subvarieties are therefore not maintained.

Flower colour was used by Schlittler to separate *E. latifolius* f. *rubens* Schlittler, with pale purple flowers, from *E. latifolius* f. *leucanthus* (Hassk.) Schlittler, with white flowers. Field and culture observations of *E. latifolius* suggest that flower colour and intensity is largely a function of flower age. The flowers open pale mauve, and then gradually fade to white and then pale cream. Individual clones may be darker or paler, but there seems to be a continuum of colour intensity. Thus the forms recognised on flower colour do not seem to be worth maintaining.

Schlittler also recognised two subforms: *E. latifolius* subf. *integerrimus* Schlittler with entire margins of the inner tepals, and *E. latifolius* subf. *fimbriatus* Schlittler with fimbriate margins of the inner tepals. The degree of tepal fimbriation varies to some extent from plant to plant but no plants have been observed where fimbriation was entirely lacking. The type of *E. latifolius* subf. *integerrimus* appears, from its description, to be at the extreme end of the scale of tepal fimbriation, and none of the specimens observed, including those from New Caledonia and other Pacific islands, showed this characteristic. While the maintenance of subform status could possibly be upheld for this isolated variant, the recognition of subforms in what is such an extremely variable species is neither worthwhile nor desirable.

### Geitonoplesium

In *G. cymosum,* the variation recognised by Schlittler (1951) consisted of leaf shape (subspecies), inflorescence branching (variety), leaf texture (subvariety), flower colour (form) and stem texture (subform).

As with *Eustrephus,* the subspecies were recognised on the basis of leaf shape: *G. cymosum* subsp. *macrophyllum* Schlittler with broad leaves, and *G. cymosum* subsp. *angustifolium* (Koch) Schlittler with narrow leaves. The leaf shape meas-

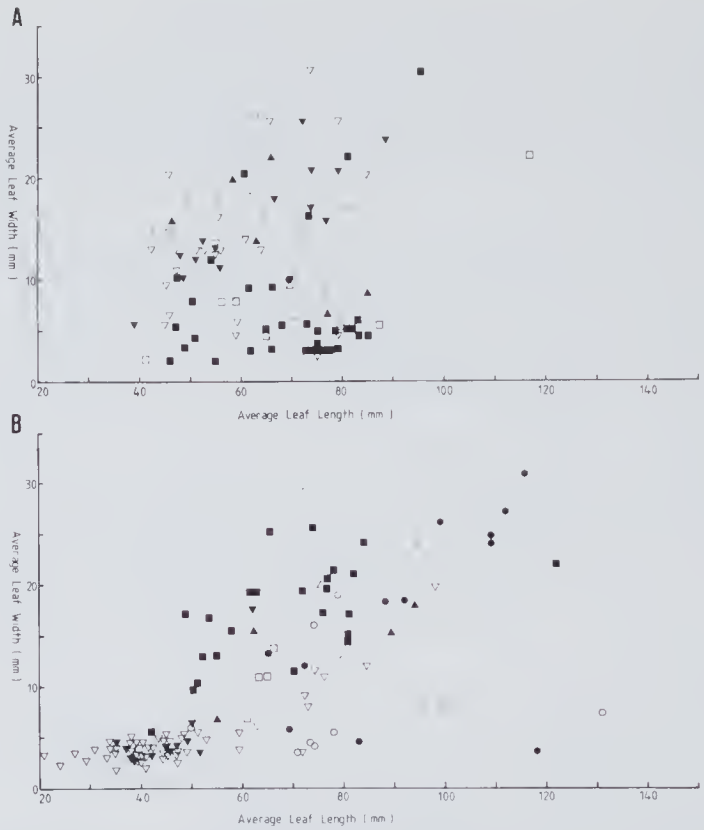


Fig. 2. Scatter diagrams of average leaf length against width showing clinal variation with latitude. a — *Eustrephus latifolius*. b — *Geitonoplesium cymosum*.
○ = 0° - 5° S. △ = > 10°-15° S. □ = > 20°-25° S. ▽ = > 30°-35° S.
● = > 5°-10° S. ▲ = > 15°-20° S. ■ = > 25°-30° S. ▼ = > 35° S.

urements did not support this division, as there was continuous clinal intergradation in leaf size (Fig. 2b), and phenotypic variation under different environmental conditions. Specimens observed in the field and under cultivation in south-east Queensland possessed broad leaves at the base of the plant and progressively narrower leaves along the stems.

The varieties recognised by Schlittler were *G. cymosum* var. *paniculatum* Schlittler and *G. cymosum* var. *timorense* (Ridley) Schlittler on the basis of whether the inflorescence was paniculate or simple. The degree of inflorescence development seems to be related to plant age and general condition, and different parts of the same plant may have simple or compound inflorescences. In his citation of specimens, Schlittler (1951) himself listed several specimens as "var. *timorense* aff. var. *paniculatum*" clearly indicating intergradation. The maintenance of varieties based on the degree of inflorescence branching therefore does not appear to be warranted.

Two subvarieties were recognised by Schlittler: *G. cymosum* subvar. *laxiflorum* (H. Hallier) Schlittler where the (dried) leaves possess inconspicuous venation, and *G. cymosum* subvar. *firmum* Schlittler where the venation is thick and prominent. The thickness, translucency and prominence of the venation in *G. cymosum* leaves is related to leaf age; immature leaves, although fully expanded, lack the thick and prominent veins of older leaves, and are translucent on drying. The degree of exposure to light also affects texture, leaves in high light intensities being more robust. The maintenance of the subvarieties defined by Schlittler therefore seems unwarranted.

The two forms recognised by Schlittler were *G. cymosum* f. *album* Schlittler with greenish-white to yellowish-white flowers, and *G. cymosum* f. *rubellum* Schlittler with dilute purple, pink to greenish-purple flowers. As with *E. latifolius,* flower colour is influenced to a large degree by the age of the flower, but in this case the purple-flowered specimens appear to occur mostly in the northern and Pacific island parts of the range, while the paler-flowered specimens are mostly on the southern, mainland part of the range. The recognition of forms on the basis of flower colour seems to be unnecessary, especially as the two forms intergrade along their geographic ranges, the distinctions are so slight, and each form is so variable.

Stem texture was used by Schlittler to separate subforms, smooth-stemmed plants being regarded as *G. cymosum* subf. *glabrum* Schlittler and plants with a rough stem texture being called *G. cymosum* subf. *asperum* (Cunn.) Schlittler. This feature seems to be highly variable, with older, thicker stems even on otherwise smooth-stemmed plants tending to have rough surfaces. The recognition of these subforms does not appear to be warranted.

## GENERAL DISCUSSION

In his discussion of the nomenclature and systematics of the two genera Schlittler (1951) states, with reference to his infraspecific taxa, that:

"The limits are, in each case, arbitrary, there are no sharp boundaries, since they also do not exist in nature." ("Die Begrenzung ist in jedem Fall willkürlich; es gibt keine scharfen Grenzen, weil sie auch in der Nature nicht vorhanden sind.")

He makes it clear that he recognises no "real" biological subunits, and that the infraspecific taxa are intended as alternative names, depending upon which character is used to classify the specimens. However, despite the taxonomic unreality of Schlittler's taxa, their names have been validly published and, as the taxa are not accepted, should be included as synonyms under the names of the two species. Conran and Clifford (1986) regarded Schlittler's infraspecific taxa as "invalid" and "illegitimate" respectively, and failed to list their validly published names in the synonymies. For the sake of completeness, their treatment should be amended to include the names in chronological sequence as synonyms under the two accepted names as follows:

**Eustrephus latifolius** R. Br. ex Ker Gawler (1809).

*E. leucanthus* Hassk., Pl. Jav. Rar. Adj. Non. Exot. Jav. Hort. Cult. 115 (1815). — *E. latifolius* f. *leucanthus* (Hassk.) Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: Buitenzorg, Indonesia, *C. A. Backer 31600* (BO n.v.).

*Luzuriaga latifolia* var *uniflora* H. Hallier, Nova Guinea 8: 993 (1914). — *E. latifolius* subvar. *uniflorus* (H. Hallier) Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: New Guinea, *Koch L15* (L!).

*E. latifolius* var. *intermedius* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: Batavia, Weltevreden, Indonesia, *C.A. Backer 26448* (BO n.v.).

*E. latifolius* subvar. *fasciculatus* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: Rockingham Bay, Australia, *F. Mueller s.n.* (L!).

*E. latifolius* f. *rubens* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: Exemplar cult. Hort. Bogor XC33a (BO n.v.).

*E. latifolius* subf. *integerrimus* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: New Caledonia, *M. Plancher s.n.*, 1870 (BO n.v.).

*E. latifolius* subf. *fimbriatus* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 214 (1951). TYPE: Daintree, N. Qld. Australia, *L. J. Brass & C. T. White* 326 (SING *fide* Schlittler loc. cit., now apparently missing).

**Geitonoplesium cymosum** (R. Br.) Cunn. ex. R. Br. (1832).

*Eustrephus timorense* Ridley in Forbes, H.O., Naturalists Wanderings E. Archip. 520 (1885). — *G. cymosum* var. *timorense* (Ridley) Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 228 (1951). TYPE: Timor, Tukskain, *H.O. Forbes 3530* (BO n.v.).

*Luzuriaga laxiflora* H. Hallier in Lorentz, Nova Guinea 8: 991, t. 180 (1914). — *G. cymosum* subvar. *laxiflorum* (H. Hallier) Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 228 (1951). TYPE: Hellwig-Gebirge, New Guinea, *Von Römer 932* (L!).

*Geitonoplesium cymosum* var. *paniculatum* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 228 (1951). TYPE: Wissel Lake Region, New Guinea, *P.J. Eyma 5303* (BO, photo only seen).

*G. cymosum* subvar. *firmum* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 228 (1951). TYPE: Wissel Lake Region, *P. J. Eyma 4368* (BO n.v.).

*G. cymosum* f. *album* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 229 (1951). TYPE: Springbrook, Queensland, *C. E. Hubbard 4236* (L!).

*G. cymosum* f. *rubellum* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 229 (1951). TYPE: Guadalacanal Island, *S. F. Kajewski 2641* (BO n.v.).

*G. cymosum* subf. *glabrum* Schlittler, Mitt. Bot. Mus. Univ. Zürich 189: 229 (1951). TYPE: Soemba, Kanangar, *Grevenst 192* (BO n.v.).

Should any of Schlittler's taxa be accepted in the future, several of the names would need to be synomymised with the autonyms created by the subdivision of the species. The continuous variation within the two species for all the characters and character suites observed does not, however, support any subdivisions within the species. Many of the taxa recognised by Schlittler represent the extreme ends of clines, but there were no places along these clines where any meaningful divisions could be made. The lack of biological reality of Schlittler's taxa (a feature which he realised) supports the relegation of the infraspecific taxa to synonymy, and accordingly none are recognised in this study.

## ACKNOWLEDGEMENTS

I have pleasure in thanking the Directors of the Queensland Herbarium (BRI), Queensland University Botany Department Herbarium (BRIU), Australian National Herbarium (CANB), Australian National Botanic Gardens Herbarium (CBG), National Herbarium of Victoria (MEL) and National Herbarium of New South Wales (NSW) for the opportunity to inspect material in their collections, and the Director of the Rijksherbarium, Leiden (L) for the loan of type material. Dr Hansjörg Eichler, Mr Les Pedley and Dr George Scott are thanked for comments on the manuscript, as is Mr Peter Young for verifying the German translation.

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# A NEW WESTERN AUSTRALIAN SPECIES OF PROSTANTHERA SECTION KLANDERIA (LABIATAE)

by

BARRY J. CONN*

## ABSTRACT

Conn, B. J. A new Western Australian species of *Prostanthera* section *Klanderia* (Labiatae). *Muelleria* 6(5): 371-374 (1987). — *Prostanthera carrickiana* is described for the first time.

## INTRODUCTION

A study of the flora of the eastern Roe botanical district by M. Burgman (Hopper 1985, *in litt.*) revealed the presence of a new Western Australian species of *Prostanthera* Labill. section *Klanderia* (F. Muell.) Benth. Although Burgman collected this new species in 1983, I was unaware of its discovery prior to the publication of my recent revision of this section (Conn 1984). This species is here described for the first time.

Terminology and presentation follows that used by Conn (1984, pp. 211-220).

## TAXONOMY

**Prostanthera carrickiana** Conn, sp. nov.

Species nova Sectionis Klanderiae. *Frutices* circa 0.5 m. alti. *Rami* et ramuli plus minusve teretes, partim dense tomentosi. *Folia* glabra; *petiolus* 0.7-1 mm. longus; *lamina* elliptica, 13-14 mm. longa, 5.5-8 mm. lata, basi subacuta, margine integro, apice subacuto. *Pedicellus florum* 2.5-2.8 mm. longus, glaber, *prophyllis* 0.7-1 mm. e basi calycis affixis. *Calyx* 6.5-7.5 mm. longus, extra glaber, intra tomentosus prope basin loborum; *tubus* 4.5-6 mm. longus; *lobi* depresse deltoidei, circa 2 mm. longi, 3.5-4 mm. lati, apice obtuso. *Corolla* 23-26 mm. longa, subrosea, extra in partibus distalibus moderate usque dense tomentosa; *tubus* 13-15 mm. longus, intra glaber; *lobus abaxiali-medianus* latissime ovatus et concavus, 2.5-3.5 mm. longus, 3.4-4 mm. latus, margine integro, apice rotundato, *lobis lateralibus* depresse ovatis usque latissime ovatis, 1.5-2 mm. longis, 2.3-4 mm. latis, margine integro, apice rotundato, *pari loborum adaxiali-mediano* depresse ovato usque latissime ovato, 6-6.5 mm. longo, 8-9.8 mm. lato, margine integro vel leviter irregulari, apice bilobato, sinu circa 1.8 mm. longo. *Stamina* circa 12 mm. e basi corollae affixa; filamenta circa 9 mm. longa; antherae 2-2.5 mm. longae, appendice absens. *Pistillum* 23-26 mm. longum; ovarium circa 0.4 mm. longum; stylus 22-25 mm. longus; lobis stigmatis 0.7-1 mm. longis. *Fructus* non visi.

TYPE: *Burgman (& McNee) 1193,* 3.v.1983, 0.5 km E. of Clyde Hill, Western Australia (Holo.: PERTH).

Erect shrub, c. 0.5 m high. *Branches* ± terete, densely hairy on the region extending from within each leaf axil to the next more distal node [at least 120 hairs/mm$^2$]; hairs simple, variously curved, antrorse to retrorse, 0.2-0.6 mm long; glands not distinct. *Leaves* glabrous; *petiole* 0.7-1 mm long; *lamina* elliptic, 13-14 x 5.5-8 mm [length to width ratio 1.6-2.4, distance of maximum width from base to total lamina length ratio 0.5], base subacute, margin entire, apex subacute; venation not visible except for midrib faint on abaxial surface. *Inflorescence* a frondose racemiform conflorescence, uniflorescences monadic; 2-6-flowered [per conflorescence]. *Pedicel* 2.5-2.8 mm long, glabrous; *prophylls* inserted 0.7-1 mm from distal end of pedicel, hence overlapping basal part of calyx [$a_1$ axis to anthopodium ratio 2-2.1], narrowly obovate, 2.3-3 x 0.8-0.9 mm [length to width ratio 2.9-3.3, distance of maximum width from base to total lamina length ratio c. 0.7], glabrous, base narrowly cuneate, margin entire, apex obtuse. *Calyx* 6.5-

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7.5 mm long, green, outer surface glabrous, inner surface glabrous except densely hairy near base of lobes [c. 116 hairs/mm$^2$]; hairs simple, c. 0.1 mm long; *tube* 4.5-6 mm long; *lobes* depressed triangular, c. 2 mm long, 3.5-4 mm wide at base [length to width ratio 0.5-0.6], apex obtuse. Corolla 23-26 mm long, pinkish-red; outer surface glabrous basally, moderately to densely hairy distally [83-100 hairs/mm$^2$]; hairs simple, usually antrorse, 0.1-0.2(-0.4) mm long; *tube* 13-15 mm long, inner surface glabrous; *abaxial median lobe* very broadly ovate, concave, 2.5-3.5 mm long, 3.4-4 mm wide [length to width ratio 0.7-0.9], margin entire, apex rounded; *lateral lobes* depressed ovate to very broadly ovate, 1.5-2 mm long, 2.3-4 mm wide [length to width ratio 0.5-0.8], margin entire, apex rounded; *adaxial median lobe-pair* depressed ovate to very broadly ovate, 6-6.5 mm long, 8-9.8 mm wide [length to width ratio 0.6-0.8], margin entire or slightly irregular, apex bilobed (sinus c. 1.8 mm long). *Stamens* inserted c. 12 mm above base of corolla [refer 'Notes']; filaments c. 9 mm long, glabrous; anthers 2-2.5 mm long, connective with a few triangular trichomes basally (trichomes c. 0.1 mm long), appendage absent. *Pistil* 23-26 mm long; ovary c. 0.4 mm long; style 22-25 mm long; stigma 0.7-1 mm long. *Mericarps* not seen. Fig. 1.

DISTRIBUTION:

Only known from near Clyde Hill (South-West: Roe), Western Australia.

ECOLOGY:

Occurs in a Mallee community with a low shrub understorey in greyish-brown sandy clay soils *(Burgman 1193).*

CONSERVATION STATUS:

Burgman (1985, p. 278) believed that this new species 'should be considered endangered' since it is only known from an area which is being developed for agricultural purposes — Risk Code = 1 or 2E (Leigh *et al.* 1981). Burgman suggested that another collection (*viz. Smolinski s.n., s. dat.,* 1.5 km NE. of Clyde Hill) also belongs to this taxon. Since I have not examined this specimen, I am unable to comment on its identity.

NOTES:

The 'Key to species' in Conn (1984, p. 288) should be changed so that this species is included. Couplet 2 should read:

2a. Leaves 5-13 mm wide* (New South Wales, Western Australia, Victoria) ..... 15
2b. Leaves up to 2.5 mm wide (Western Australia) ..... 3

and the following couplet should be inserted:

15a. Leaves 15-50 mm long, corolla 30-35 mm long, prophylls 10-18 mm long (New South Wales, Victoria) ..... 13. *P. monticola*
15b. Leaves 13-14 mm long, corolla 23-26 mm long, prophylls 2.3-3 mm long (Western Australia) ..... *P. carrickiana*

In the description it is stated that the 'Stamens are inserted c. 12 mm above base of corolla'. It would be more correct to state that the stamens and corolla are adnate to about 12 mm above the base of corolla because the course of the filaments on the corolla may be observed as slightly raised lines for most of its length.

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* Couplet 2a in Conn (1984, p. 288) states 'Leaves 5-13 mm long . . .'. This is a typographical error which should be corrected to 'Leaves 5-13 mm wide . . .'.


Fig. 1. *Prostanthera carrickiana*. a — twig and flowers, x 1. b — flower, x 2. c — stamen, dorsal view, x 12. d — stamen, ventral view, x 12. All from *Burgman (& McNee) 1193*.

The affinities of this new species are unclear. Considering all the species of *Prostanthera* section *Klanderia,* the relatively broad leaves of *P. carrickiana* are reminiscent of *P. monticola* and *P. porcata* of south-eastern Australia. There does not appear to be a close relationship with any of the Western Australian species of section *Klanderia* or with those of section *Prostanthera.*

ETYMOLOGY:

The specific epithet honours John Carrick whose principal research interest was directed towards a revision of the Prostantheroideae until his untimely death in 1978. For brief biographies of J. Carrick refer Anonymous (1979) and Henderson (1978).

## ACKNOWLEDGEMENTS

I wish to thank Dr S. Hopper of the Western Australian Wildlife Research Centre for notifying me of this new species, R. H. Barley of MEL for skilfully illustrating it, and Dr J. Green and staff of PERTH for making the *Burgman* collection available for loan.

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# A STUDY OF THE VARIATION WITHIN AND BETWEEN PROSTANTHERA MONTICOLA AND P. WALTERI (LABIATAE) USING LEAF VOLATILE OILS

by

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## ABSTRACT

Conn, B. J. & Whiffin, T. A study of the variation within and between *Prostanthera monticola* and *P. walteri* (Labiatae) using leaf volatile oils. *Muelleria* 6(5): 375-382 (1987). — The leaf volatile oils showed a marked distinction between *Prostanthera monticola* and *P. walteri,* supporting the morphologically-based taxonomic conclusion that they represent two species. The pattern of variation within each species was found to reflect the isolated, perhaps relictual nature of the populations.

## INTRODUCTION

*Prostanthera monticola* and *P. walteri* (together with *P. porcata*) occupy a taxonomically unique position within section *Klanderia.* All three species have larger leaves and slightly larger flowers than those of the other species in this section. Although most of the species of section *Klanderia* are confined to the lowland arid and semi-arid regions (as defined by Gentilli 1972), these three species occur in the mountainous subhumid region at altitudes above 450 metres. *Prostanthera monticola* and *P. walteri* are the only species of this section which occur above the snow-line, at altitudes up to 1833 metres.

In a revision of *Prostanthera* section *Klanderia,* Conn (1984) recognized *Prostanthera monticola* as a species which was morphologically distinct from *P. walteri.* Prior to this, the name *P. walteri* had been collectively applied to these two taxa, even though Willis (1973) realized that *P. walteri* (*s.str.*) was, at least in part, distinct from other populations which were also referred to this species. The main morphological features which distinguish these two species are that *P. monticola* has prophylls which are 10-18 mm long (cf. 4-6.5 mm long in *P. walteri*) and has a hairy inner surface of the calyx-lobes (cf. glabrous in *P. walteri*).

*Prostanthera monticola* occurs in the Southern Tablelands of New South Wales and at Mount Buffalo in Victoria, whereas *P. walteri* occurs in East Gippsland of Victoria and at Mt Imlay (South Coast) in New South Wales (Fig. 1). The two species tend to occur as relatively small, isolated populations which are confined to mountain tops and ridges.

The purpose of this study was to examine the pattern of variation within and between the two species using leaf volatile oils. This information proved useful in two main ways. Firstly, it allowed an assessment of the extent to which these characters supported the morphologically-based distinction between the two species. Secondly, it provided information on the amount of differentiation within each species.

No other works on the leaf volatile oils of *Prostanthera,* except that of Conn (1984), have been published, although E. V. Lassak (pers. comm.) has investigated some species. Conn used leaf volatile oils to give a brief taxonomic evaluation of the infrageneric classification proposed by Bentham (1870) and to evaluate the patterns of geographic variation of *P. aspalathoides.*

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## MATERIALS AND METHODS

Collections were made from two populations of *P. monticola* and four populations of *P. walteri,* representing as far as possible the distributional range within each species (Table 1 & Fig. 1). The other known populations of *P. monticola* (Fig. 1) could not be relocated. This species is apparently very rare (in New South Wales) and each population comprises a few scattered plants which are easily overlooked. Fresh foliage samples were collected separately from eight plants per population (except five from population W3), sealed in polyethylene bags and stored at approximately 2°C until processed. The voucher plant material which was

Table 1. Details of the two populations of *P. monticola* and four populations of *P. walteri* studied for leaf volatile oils.

| Species | Population Code | Locality | Collection Numbers | Number of Specimens |
|---|---|---|---|---|
| P. monticola | M1 | Crystal Brook Falls | Conn 1422A, 1422B-1428 | 8 |
| ” | M2 | Middle Creek | Conn 1429-1432A, 1432B-1435 | 8 |
| P. walteri | W1 | Mt Elizabeth II | Conn 1405-1412 | 8 |
| ” | W2 | Mt Ellery | Conn 1397-1404 | 8 |
| ” | W3 | Mt Kaye | Forbes 1967-1971 | 5 |
| ” | W4 | Mt Imlay | Conn 1388-1395 | 8 |

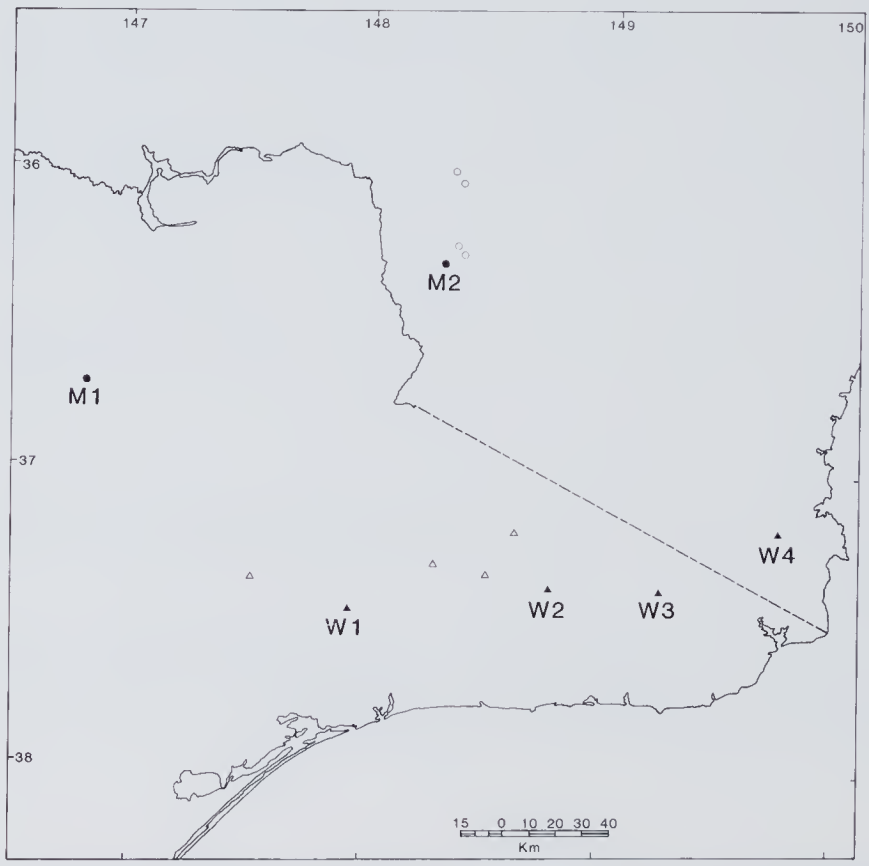



Fig. 1. Distribution map of *Prostanthera monticola* and *P. walteri. P. monticola* — ● populations sampled in this study; ○ other known populations. *P. walteri* — ▲ populations sampled; △ other known populations.

Table 2. Population means and ranges, with F-values for the twelve more important compounds (those for which the population mean was greater than 5% in one or more populations). All compounds are significant at the 0.001 level.

| CHARACTERS | POPULATIONS | | | | | | F-Value |
|---|---|---|---|---|---|---|---|
| | M1 Mean (Range) | M2 Mean (Range) | W1 Mean (Range) | W2 Mean (Range) | W3 Mean (Range) | W4 Mean (Range) | |
| 8 | 42.341 (23.217-58.246) | 9.368 (4.142-19.650) | 0.139 (0.003-0.296) | 0.102 (0.013-0.311) | 0.389 (0.180-0.666) | 0.543 (0.111-1.561) | 90.497 |
| 13 | 0.382 (0.021-1.886) | 0.925 (0.353-2.205) | 0.873 (0.248-2.887) | 6.591 (1.086-12.840) | 4.300 (0.510-9.235) | 1.449 (0.459-4.834) | 9.083 |
| 20 | 10.886 (4.538-13.992) | 13.319 (7.676-23.241) | 15.716 (8.796-21.635) | 10.514 (5.516-21.802) | 4.913 (2.166-7.098) | 7.559 (5.072-10.968) | 6.741 |
| 22 | 2.308 (0.231-9.084) | 7.119 (5.192-11.370) | 0.412 (0.200-0.893) | 0.733 (0.515-1.050) | 0.470 (0.310-0.793) | 0.201 (0.003-0.760) | 26.726 |
| 29 | 0.477 (0.183-0.805) | 1.244 (0.927-1.568) | 1.660 (1.306-2.218) | 1.063 (0.570-2.271) | 6.089 (2.492-12.812) | 2.070 (0.246-6.868) | 5.661 |
| 33 | 2.405 (0.050-5.705) | 5.235 (2.871-6.407) | 0.163 (0.080-0.378) | 0.319 (0.148-0.479) | 0.137 (0.003-0.285) | 0.193 (0.121-0.290) | 34.758 |
| 38 | 3.898 (1.606-5.527) | 6.321 (3.957-7.862) | 0.422 (0.137-0.699) | 1.451 (0.003-5.412) | 0.256 (0.003-0.951) | 0.688 (0.003-1.525) | 36.681 |
| 56 | 2.066 (0.722-4.572) | 2.116 (0.003-3.561) | 5.405 (1.811-8.473) | 17.287 (6.738-24.141) | 5.512 (2.179-10.765) | 2.943 (0.809-6.788) | 26.665 |
| 60 | 0.519 (0.069-2.338) | 3.644 (0.627-7.570) | 6.069 (2.095-12.238) | 2.170 (0.699-3.655) | 1.202 (0.332-1.746) | 9.437 (2.162-24.656) | 6.353 |
| 65 | 0.212 (0.072-0.516) | 0.278 (0.003-0.474) | 5.747 (1.604-14.481) | 10.579 (5.603-20.051) | 6.388 (2.893-15.895) | 4.434 (2.122-7.899) | 11.427 |
| 75 | 1.378 (0.243-3.372) | 0.389 (0.111-0.939) | 12.737 (4.566-23.484) | 17.423 (4.419-31.359) | 14.138 (5.360-22.457) | 9.673 (3.580-15.326) | 10.345 |
| 85 | 0.093 (0.003-0.335) | 0.040 (0.003-0.266) | 0.317 (0.003-0.895) | 0.112 (0.003-0.466) | 6.069 (1.182-11.752) | 4.793 (2.102-11.611) | 11.294 |

collected from each individual is lodged at the National Herbarium of Victoria (MEL).

The leaves were steam distilled and the volatile oils were recovered according to the methods detailed by Whiffin (1982) and Newnham *et al.* (1986). The oils were analyzed by gas chromatography, with the percentage composition determined using the methods of Newnham *et al.* (1986).

The data were subjected to a one-way analysis of variance (ANOVA) and Student-Newman-Keuls (SNK) multiple range test to determine, respectively, which compounds showed significant differences between populations, and which populations were involved. Population means of selected significant compounds were submitted to contour mapping to illustrate the pattern of variation present within these characters.

Multivariate analyses involved submitting the Manhattan Metric distance matrix between individuals and, separately, that between population means, to clustering, ordination and minimum spanning tree procedures. The analyses included: clustering by use of the fusion criteria of unweighted pair-group method using averages (UPGMA) and weighted pair-group method using averages (WPGMA); ordination by principal coordinates analysis (PCDA); and computation of a minimum spanning tree. Where different analyses produced essentially similar results, only one set of results is presented here.

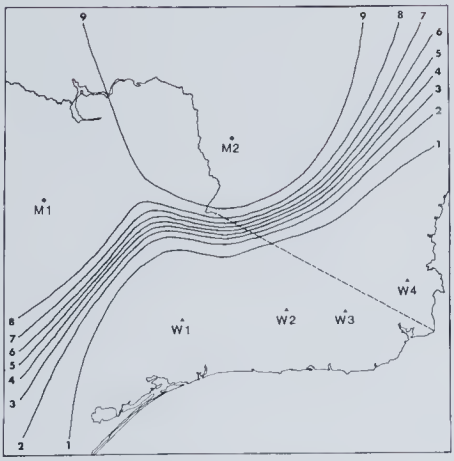
The rationale for the use of these various univariate and multivariate techniques in the study of variation is provided by Whiffin (1982). The methods and computer programs used here are those detailed by Whiffin (1982), except that multivariate techniques were undertaken using the NT-SYS program package (Rohlf 1985).

## RESULTS

A total of 191 compounds were detected within the volatile oils of the two species. The results relating to the twelve more important compounds (those for which the population mean was greater than 5% in one or more populations) are presented in Table 2. In the analysis of variance, 136 of these 191 compounds were significant at the 0.05 level, of which 104 were also significant at the 0.01 level. In fact, 78 compounds were significant at the 0.001 level. In the results from the SNK test, which is generally a more robust test (Adams & Turner 1970), 95 compounds showed significant differences between populations at the 0.01 level.

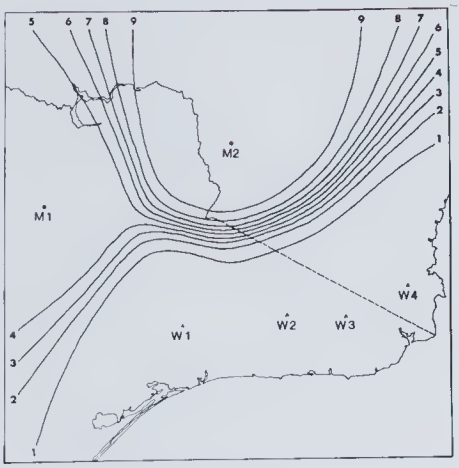
A study of the significant compounds by contour mapping and an examination of their SNK test results showed that they could be placed into one of two groups, each representing a different major pattern of variation. The first group showed a pattern of variation involving a distinction between the two populations of *P. monticola* and the four populations of *P. walteri*. An example of this pattern is found in compound 43 (Table 2 & Fig. 2). Included in this group are a number of compounds which also show a significant difference between the two populations of *P. monticola*, in addition to the significant difference between the two species. Examples of this latter pattern include many of the more important, and generally more highly significant compounds, such as compounds 8, 33 and 38 (Table 2 & Fig. 3). Some other compounds show this basic pattern, although they exhibit a slight overlap between the two species in the SNK test. Examples of this pattern include compounds 13, 65 and 75 (Table 2).

The second group of compounds show a pattern of variation involving a significant difference between one population and all other populations, of either species. Examples of this pattern include compound 56 (Table 2 & Fig. 4), which shows population W2 as being significantly distinct from all others, and compound 29 (Table 2 & Fig. 5) which shows population W3 as being significantly distinct from all others. Within the 95 compounds that have significant SNK tests, examples can be found where each of the six populations in turn show a significant difference from the other five together. The more common patterns involve the distinction of populations M2 or W4.



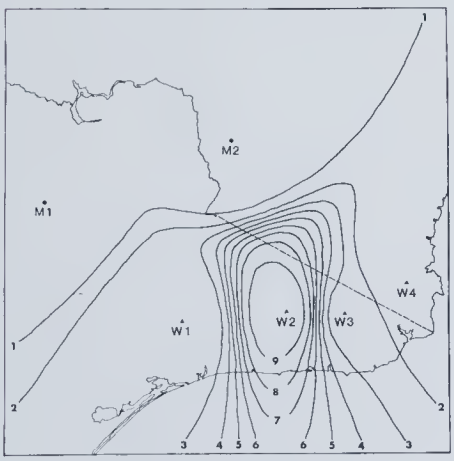

M2 M1 W3 W1 W4 W2

Fig. 2. Contour map (with summary of SNK test) of percentage composition of compound 43 for populations of *P. monticola* and *P. walteri*. Contour values are: 1 = 0.154, 2 = 0.407, 3 = 0.660, 4 = 0.913, 5 = 1.166, 6 = 1.413, 7 = 1.672, 8 = 1.925, 9 = 2.178.



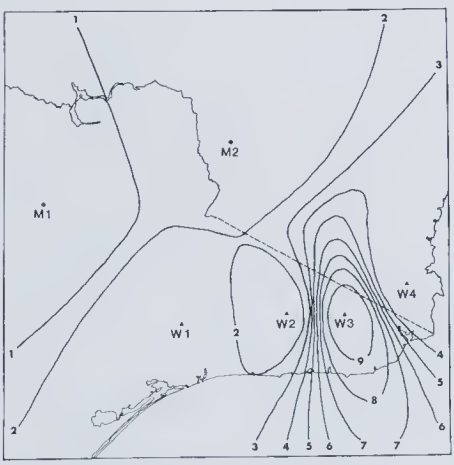

M2 M1 W2 W4 W1 W3

Fig. 3. Contour map (with summary of SNK test) of percentage composition of compound 33 for populations of *P. monticola* and *P. walteri*. Contour values are: 1 = 0.421, 2 = 0.987, 3 = 1.553, 4 = 2.120, 5 = 2.686, 6 = 3.253, 7 = 3.819, 8 = 4.385, 9 = 4.952.




W2 W3 W1 W4 M2 M1

Fig. 4. Contour map (with summary of SNK test) of percentage composition of compound 56 for populations of *P. monticola* and *P. walteri*. Contour values are: 1 = 2.910, 2 = 4.599, 3 = 6.288, 4 = 7.976, 5 = 9.665, 6 = 11.354, 7 = 13.042, 8 = 14.731, 9 = 16.420.




W3 W4 W1 M2 W2 M1

Fig. 5. Contour map (with summary of SNK test) of percentage composition of compound 29 for populations of *P. monticola* and *P. walteri*. Contour values are: 1 = 0.788, 2 = 1.410, 3 = 2.032, 4 = 2.655, 5 = 3.277, 6 = 3.899, 7 = 4.521, 8 = 5.143, 9 = 5.766.

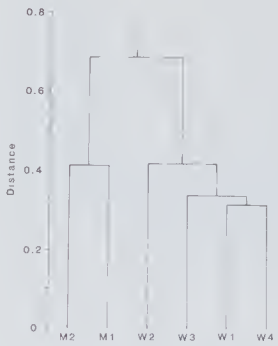



Fig. 6. Dendrogram from the cluster analysis (unweighted pair-group method) of the populations of *P. monticola* and *P. walteri* based on leaf volatile oil composition.

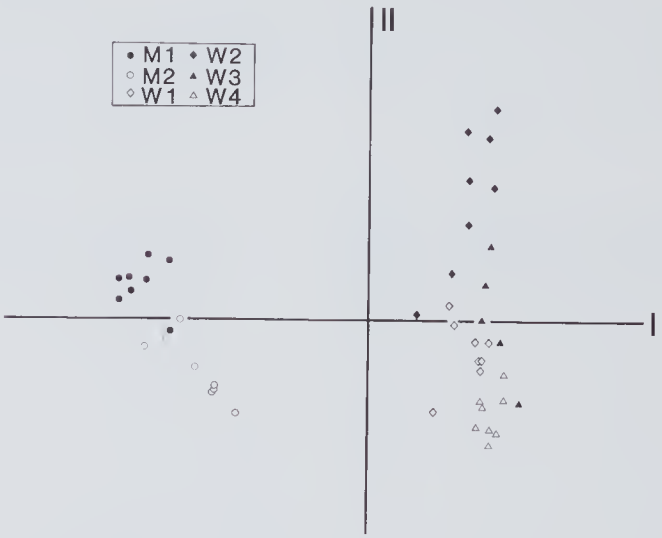



Fig. 7. Principal coordinates analysis ordination plot of the individuals of *P. monticola* and *P. walteri* based on leaf volatile oil composition (axis 1 accounts for 46% of the total variation and axis 2 for 14%).

These two major patterns of variation account for most of the more important or more highly significant compounds. Thus, of the twenty more highly significant compounds (with an F-value greater than 20.0 in the analysis of variance), six show a significant difference between the two populations of *P. monticola* and the four populations of *P. walteri* (cf. Fig. 2). A further three show a significant difference between the two populations of *P. monticola* (cf. Fig. 3), as well as a significant difference between the species. Five more compounds show this basic pattern of distinction between the two species, but with a slight overlap between the two. Within the remaining six more important compounds, five show the second major pattern of variation, distinguishing one population from all others, variously involving populations M2, W2 or W4 (cf. Figs 4 & 5). The last compound distinguishes W3 and W4 from each other, and from the other four populations together.

Of the twelve more important compounds (Table 2), three (compounds 8, 33 and 38) distinguish M1 from M2, and from all other populations. A further three (compounds 13, 65 and 75) distinguish the two species, although with a slight degree of overlap. Three compounds distinguish one population from all others, involving population M2 (compound 22), population W2 (compound 56), and population W3 (compound 29). Of the remaining compounds, one distinguishes

populations W3 and W4 together from all other populations (compound 85), whereas the other two provide a less distinct separation of individual populations (compounds 20 and 60).

The remaining significant compounds, those not showing one of the two major patterns of variation, show various patterns. However, most can be related back to one of the two major patterns, but with greater overlap between the distinguished groups.

The cluster analysis of the population means (Fig. 6) shows that there is a clear distinction between the two species, whereas within each species the populations are relatively distinct. The results from the other multivariate analyses of these data (ordination and minimum spanning tree) provided essentially the same results.

In the multivariate analyses of the individuals, the clustering, ordination and minimum spanning tree analyses are similar. As the ordination results are visually easier to comprehend, they are presented here (Fig. 7). The first two axes of the principal coordinates analysis provide a useful simplification of the data because they account for 59.47% of the total variation. The ordination on these axes produces distinct clusters. The major distinction, on axis 1, is between the two populations of *P. monticola* and the four populations of *P. walteri*. Variation within *P. walteri* was projected mainly on axis 2, whereas that within *P. monticola* was projected mainly on axis 3. The various populations within each species are relatively homogeneous, with the individuals of a given population grouping together in the ordination plot (and cluster dendrogram), although there is some overlap of the various population clusters.

## DISCUSSION

The results from all analyses undertaken, both univariate and multivariate, indicate a basic similarity between the two species on leaf volatile oil composition, concordant with a common ancestry for the two, but with sufficient quantitative differences to confirm their recognition as distinct species. This distinction between the two species, based on the volatile oils, confirms the conclusions drawn from the morphological data (Conn 1984).

The patterns of variation observed, within and between populations, may reflect the separate, perhaps relictual, nature of the six populations. The individuals within any one population showed a tendency to group together, separate from other populations, in the multivariate analyses (eg. ordination, Fig. 7). Paralleling this, in the SNK tests, each population was significantly different from all others for at least one compound. This suggests that there has been separate evolution, relating to selection or genetic drift, within each population, with little or no gene flow between the populations, at least in recent times.

## ACKNOWLEDGEMENTS

We wish to thank Stephen Forbes (MEL) for the collections of *P. walteri* from Mt Kaye and Rhonda Parish (La Trobe University) for her expert technical assistance.

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# TWO NEW LICHENS: CLADONIA SQUAMOSULA VAR. SUBSQUAMOSULA AND C. SULCATA VAR. STRIATA WITH NOTES ON CHEMOTAXONOMY WITHIN THE SPECIES

by

ALAN W. ARCHER*

## ABSTRACT

Archer, Alan W. Two new lichens: *Cladonia squamosula* var. *subsquamosula* and *C. sulcata* var. *striata* with notes on chemotaxonomy within the species. *Muelleria* 6(5): 383-388 (1987). — Two new lichen varieties, *Cladonia squamosula* var. *subsquamosula* which occurs in Australia and *Cladonia sulcata* var. *striata* which occurs in Australia and New Zealand, are described and the chemotaxonomy of all Australian varieties within the two species is discussed. Additional distribution data is reported for *C. sulcata* var. *sulcata* and *C. sulcata* var. *wilsonii*.

## INTRODUCTION

The exact level at which chemical variations in the lichen-forming fungi should be given taxonomic recognition has been the subject of much discussion (Hawksworth, 1974; Hawksworth, 1976; Brodo, 1978; Elix *et al.*, 1984). It has been suggested that some taxonomic recognition should be given to morphologically similar materials which differ chemically (Brodo, 1978) although there is at present no general agreement among lichenologists as to the level at which such recognition should be given. This paper describes new chemical variations in two species in the lichen genus *Cladonia, C. squamosula* Müll. Arg. and *C. sulcata* A. W. Archer. The taxa possessing these variations are here described as new varieties, following the guidelines proposed by Hawksworth (Hawksworth, 1976) for the naming of chemical variations *(vide infra)*.

## METHOD

The lichen compounds present in the specimens examined were identified by thin-layer chromatography of acetone extracts, using the mobile phases described by Culberson (Culberson, 1972; Culberson *et al.*, 1981) and the separated compounds were detected with sulphuric acid (Culberson, 1972) and MBTH (Archer, 1978). The presence of bourgeanic acid was confirmed by mass spectrometry (cf. Bodo *et al.*, 1973). Fertile specimens of *Cladonia squamosula* contain barbatic acid and this compound is not well separated from homosekikaic acid using the standard conditions for thin-layer chromatography (Culberson, 1972). An improved separation of these two compounds was obtained on silica by using a mobile phase composed of: ethyl acetate 75/ ethanol 20/ ammonia 5. In this system the following Rf values were obtained: thamnolic acid, 0; barbatic acid, 0.3; homosekikaic acid, 0.6. The presence of homosekikaic acid was also confirmed by high performance liquid chromotography (J. A. Elix *in litt.*, 1985).

## TAXONOMY

**Cladonia squamosula.** Müll. Arg. Flora, Jena 66: 19 (1883) var. **squamosula.** TYPE: Australia, Queensland, Toowoomba; Hartmann, 1882. (HOLOTYPE: G!; ISOTYPE: MEL 6551!).

*Cladonia subsquamosa* var. *pulverulenta* Vainio, Acta Soc. Fauna Flora fennica 4: 449 (1887). — *Lichen pulverulentus* R. Brown ex Bennett, Iter. austr. 531 (1876),

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*nom. nud. in sched.;* R. Brown ex Vainio, Acta Soc. Fauna Flora fennica 4: 449 (1887), *nom. nud. pro syn.* — *Cladonia pulverulenta* Crombie, J. Linn. Soc. Bot. 17: 392 (1880), *nom. nud. pro syn.* TYPE: Australia [Tasmania], "Mons Tabulans" [Mt Wellington], 1802-05, *R. Brown* ex Bennett, Iter. austr. 531 (HOLOTYPE: BM!)

*Cladonia elegantula* Müll. Arg. Flora, Jena 70: 56 (1887). — *Cladonia squamosula* f. *elegantula* (Müll. Arg.) des Abb., Revue Bryol. Lichénol. 34:824 (1966). TYPE: Australia, New South Wales, Illawarra, 1881, *Kirton.* (LECTOTYPE (see Des Abbayes, 1966): G!. ISOLECTOTYPES: MEL 6547!, NSW L4392!). Victoria, Ovens River, 1882, *McCann.* (SYNTYPES: G!, MEL 6541!).

ALSO EXAMINED:

*Western Australia* — Stirling Range, Toolbrunup Peak, 19.iv.1980, *? coll.* (PERTH 000906).

*South Australia* — Ashbourne, 40 km SSE. of Adelaide, 2.vi.1964, *D. J. Whibley 1397* (AD 97519493); Lower Mt Lofty Range, 55 km SSW. of Adelaide, - .vi.1968, *V. Cruickshank* (AD 97410442); Mt Compass, 50 km S. of Adelaide, 7.vii.1968, *V. Cruickshank* (AD 97410446); Honans Scrub, 25.vii.1980, *N. Donner 7034* (AD 4877); near Glenelg River, South Australia/Victoria border, 26.vii.1980, *N. Donner 7058* (AD 4867).

*Queensland* — Allumbah, "North Queensland", 29.iii.1910. *B. Waller* (NSW, L1918); Amity Point, Stradbroke Island, 16.v.1973, *R. Rogers 2178* (BRIU); Near Mt Coolum, 100 km N. of Brisbane, 1981, *N. Stevens* (BRIU); Kirrima Rd, 32 km WNW. of Cardwell, 20.vi.1984, *H. Streimann 28714* (CBG); Wallam Falls Rd, 27 km W. of Ingham, 21.vi.1984, *H. Streimann 28816* (CBG).

*New South Wales* — Parramatta, 1.x.1900, *E. Cheel* (NSW); Exeter, -.x.1907, *Miss Betts* (NSW); Mt Boss State Forest, 51 km NW. of Wauchope, 20.x.1978, *H. Streimann 7142* (CBG); Guerilla Bay, 2.ix.1981, *H. Streimann 15710* (CBG).

*Australian Capital Territory* — Condor Creek, 25 km W. of Canberra, 1.ix.1981, *A. Archer 1114* (BM, NSW); Mt Franklin Road, near Mt Aggie, 14.xi.1981, *A. Archer 1206C* (NSW); Kowen Forest, 18 km W. of Canberra, *H. Streimann* (CBG); Little Collins Creek, Brindabella Range, 34 km SW. of Canberra, *H. Streimann* (CBG); Booroomba Rocks, 30 km SSW. of Canberra, *H. Streimann* (CBG).

*Victoria* — Mt Macedon, - .iv.1886, F.R. M. Wilson (NSW); Oakleigh, 7.x.1887, *F. R. M. Wilson* (NSW L3803); Trentham, -.xi.1887, *F. M. Campbell* (NSW); Tyers Lake, -.vi.1889, *F. R. M. Wilson* (NSW); Whitehorse Creek, Blue Range, 24.ix.1964, *R. Filson 6509* (MEL 40188).

*Tasmania* — Notley Gorge, 26.xi.1983, *A. Archer 1720* (NSW); Beaties Tarn, 9 km N. of Maydena, 6.xii.1983, *A. Archer 1638A* (NSW); Gordon Road, near Mt Wedge, 16.xii.1983, *G. Kantvilas 132/83.*

*Lord Howe Island* — Mt Gower, -.viii.1911, *W. W. Watts* (NSW L1920).

DISCUSSION:

Des Abbayes (1966) examined J. Müller's specimens of *C. squamosula* and *C. elegantula* from Geneva and selected Kirton's specimen from New South Wales as the lectotype of *C. elegantula.* He concluded that *C. elegantula* was only a form of *C. squamosula* possessing small isidioid squamules, in contrast to the larger squamules characteristic of typical *C. squamosula.* Both of these forms are found, together with intermediate forms which possess large conspicuous squamules near the base of the podetia with a decrease in size towards smaller isidioid squamules near the apices of the podetia. Thus the separation of form *elegantula* can no longer be justified and it is here reduced to synonymy with *C. squamosula* var. *squamosula.* An examination of the holotype of *C. squamosula* and all type material of *C. elegantula* showed that none contained homosekikaic acid.

*C. squamosula* var. *squamosula* is widely distributed throughout Australia where it grows on dead wood. It also occurs in New Zealand and has recently been reported from Chile (Ahti and Kashiwadani, 1984).

**Cladonia squamosula** Müll. Arg. var. **subsquamosula** A. W. Archer, var. nov.

*Cladonia intermedia* Krempelh. ex F. Wilson, Pap. Proc. Roy. Soc. Tasmania 1892: 151 (1893), *nom. nud.*

*Cladonia intermedia* "(Del. ex Nyl.) Wils." sensu Wetmore, Rev. Bryol. Lichénol. 32: 247 (1963), non *Cladonia fimbriata* var. *coniocraea* f. *intermedia* Delise ex Nyl. Prodr. Lich. Novae Caled.:3 (1859).

Sicut *Cladonia squamosula* var. *squamosula* sed acidum homosekikaicum continens. Thallus K+ flavescens, Pd+ flavescens; acida thamnolicum et homosekikaicum continens.

*Primary squamules* persistent, 1-3 mm long, 0.5-1 mm wide, subpalmately lobed, margins crenate to incised, green above, white below. *Podetia* growing from the upper surface of the primary squamules, 10-20(-25) mm tall, 0.5-1.5 mm diam., cylindrical or tapering towards the apices, simple or rarely branching, escyphose, sterile podetia acute; podetia ecorticate and squamulose, squamules c. 0.3 mm long near the base of the podetia, becoming smaller and isidioid, 0.1 mm long, near the apices; podetial wall 0.15-0.2 mm thick, *Apothecia* brown to dark brown, clustered, 0.5-1.5 mm diam., terminal on podetia, the tips of fertile podetia often open to the interior. *Ascospores* eight per ascus, colourless, simple, ellipsoid, 12-15 μm long, 3-4 μm wide. *Thallus* K+ yellow, KC−, Pd+, yellow; containing thamnolic and homosekikaic acid, with barbatic acid in the apothecia.

TYPE COLLECTION:

Australia, New South Wales, Wentworth Falls, 90 km W. of Sydney, 150° 22′ E, 33° 45′ S, alt. c. 900 m, 1.vi.1985, *Archer 1751* (HOLOTYPE: MEL 1048970. ISOTYPE: NSW).

ALSO EXAMINED:

*Western Australia* — Porongorup Range National Park, 40 km N. of Albany, 15.x.1980. *N. Sammy* (PERTH 810024 & 810111); 1bidem 17.x.1980, *N. Sammy* (PERTH 810085).

*South Australia* (selected specimens only, 5/18) — Hahndorf, 25 km SE, of Adelaide, 27.viii.1971, *N. Donner 3685* (AD 97410365); West end of Kangaroo Island, 12.ix.1971, *G. Jackson 823* (AD 9206); Comaun Forest, 30 km SE. of Naracoorte, 3.v.1973, *R. Seppelt 2537* (AD 97645142); Mt Lofty Ranges, 7 km E. of Springton, alt. 300 m, 17.xii.1976, *J. A. Elix* (ANUC); Barossa Range, Menglers Hill, 4 km E. of Tanunda, 27.x.1981, *J. A. Elix* (ANUC).

*New South Wales* (selected specimens only, 5/12) — 50 km E. of Glen Innes along Highway 38, alt. 1000 m, 18.viii.1976, *J. A. Elix* (ANUC); 85 km E. of Armidale, alt. c. 1400 m, 14.x.1977, *Archer 415* (NSW); Below Tianjara Falls, 33 km NNE. of Ulladulla, alt. 380 m, 21.v.1979, *J. A. Elix* (ANUC); Guerilla Bay, 150° 13′ E, 35° 40′ S, alt. c. 50 m, 28.v.1983, *Archer 1731* (NSW); Berowra Creek, Galston Gorge, 30 km NW. of Sydney, alt. 50 m, 16.ii.1985, *Archer 1725* (CBG, G).

*Victoria* — 12 km E. of Marlo, alt. 10 m, 20.xi.1978, *J. A. Elix,* (ANUC).

*Tasmania* — Cladonia intermedia sensu Krempelhuber, sine loc., *Dr. Story,* (M, MEL 6651); Snug Falls Track, *G. Bratt & M. Bratt 3474* (HO 40449); Russell Falls Track, *G. Bratt & J. Cashin 73/508* (HO 40492).

*Norfolk Island* — Mt Pitt, on stump of *Cyathea brownii,* 27.xii.1981, *R. Goldsack* (NSW).

DISCUSSION:

*Cladonia squamosula* var. *subsquamosula* is distinguished from var *squamosula* in containing homosekikaic acid.

The new variety has a restricted distribution when compared with that of var. *squamosula.* It occurs on dead wood in south-western Western Australia, south-eastern South Australia, Victoria, eastern New South Wales and Tasmania. The material from Tasmania collected by Dr G. F. Story (a military surgeon in Tasmania (Kantvilas, 1983)) was sent to A. von Krempelhuber in Munich who gave the specimen the manuscript name "Cladonia intermedia" but the name was never validly published as neither Wilson (1893) nor Wetmore (1963) gave a description or diagnosis of the taxon. Both of the specimens of Story's Tasmanian collection housed at Munich and Melbourne contain thamnolic and homosekikaic acids and are included in *C. squamosula* var. *subsquamosula.* The occurrence of homosekikaic acid, an orcinol meta depside, with thamnolic acid, a β-orcinol meta depside, is unusual. Homosekikaic acid is not biogenetically related to thamnolic acid and therefore var. *subsquamosula* falls into category 3C of Hawksworth's proposed guidelines for the taxonomic treatment of chemical variations in lichens (Hawksworth, 1976, Table 1, p. 157) i.e. the presence of a biogenetically distinct compound allied to distributional differences. Hawksworth (1976) suggested the rank of variety for taxa showing this type of chemical variation and this proposal has been followed here. Homosekikaic acid is reported to occur with β-orcinol depsidones in the sub-generic group *Helopodium* and in the sub-groups *Cladonia* and *Furcatae* (Huovinen & Ahti 1982) and is here reported to occur in the group *Squamosae,* to which group *C. squamosula sens. lat.* belongs. The structure of homosekikaic acid has

some features in common with didymic acid, which occurs with thamnolic acid in the sub-generic group *Cocciferae*. It is possible that both didymic and homosekikaic acids are formed from the same pair of polyketides, one with a pentyl group and one with a propyl group. Two synthetic routes are suggested, one involving esterification and o-methylation to form homosekikaic acid and the other, to give didymic acid, involving decarboxylation and formation of a C-C bond with loss of water to form a furan ring. A quantitative examination of a specimen of *C. squamosula* var. *subsquamosula* (*Archer 943,* H) by high performance liquid chromatography, (Huovinen *et al.,* 1985) showed the specimen to contain 0.2% thamnolic acid and 0.46% homosekikaic acid (K. Huovinen *in litt.,* 1985). Traces of sekikaic acid were also present.

**Cladonia sulcata** A. W. Archer, Muelleria 5:115 (1982) var. **sulcata.**

*Cladonia sulcata* was originally reported to occur only in Victoria and Tasmania (Archer, 1982) but the range of var. *sulcata* now extends from South Australia to New Zealand.

Additional Specimens Examined:

*Australia, South Australia* — Mt Lofty Ranges, 3.xi.1968, *R. Rogers 1515* (AD97649657).

*Australian Capital Territory* — Smokers Gap, Corin Dam Rd, alt. 1200 m, 2.v.1982, *A. W. Archer 1318A* (ANUC, H).

*New Zealand: North Island* — North Auckland, Mangonui County, Karikari Peninsula, *J. K. Bartlett 28919* (WELT). *South Island* — Nelson, Dun Mt, *J. K. Bartlett 19805* (WELT).

**Cladonia sulcata** var. **wilsonii** (A. W. Archer) A. W. Archer & J. K. Bartlett, New Zealand J. Bot. (in press).

*Cladonia wilsonii* A. W. Archer, Muelleria 5: 274 (1984).

*Cladonia wilsonii* was originally reported to occur only in Australia (Archer, 1984) but the known range now extends south and east to Macquarie Island (Filson and Archer, 1986) and New Zealand (Archer and Bartlett, *loc. cit.*).

**Cladonia sulcata** var. **striata** A. W. Archer, var. nov.

*Cladonia diffissa* auct.

Sicut *Cladonia sulcata* var. *sulcata* sed acidum norsticticum continens. Thallus K+ flavescens; KC−; Pd+ flavescens; atranorinum et acida norsticticum et bourgeanicum continens.

*Primary squamules* persistent or evanescent, 1-2 mm wide, 2-4 mm long, green above, white below, esorediate. *Podetia* arising from the squamules, 10-20(-30) mm tall, greyish white, simple at the base and then becoming branched, each branch longitudinally grooved and becoming split, axils open; cortex continuous at the base, then becoming verruculose and areolate; esorediate; podetial wall 100-250 μm thick. *Apothecia* always present on the tips of the podetia, dark brown to reddish-brown, convex, 0.4-0.8 mm diam., *ascospores* eight per ascus, colourless, simple, ellipsoid, 12-14 μm long, 3-4 μm wide. *Thallus* K+ weak yellow; KC−; Pd+ yellow; containing atranorin, norstictic and bourgeanic acids.

Type Collection:

Australia, New South Wales, near First Rocks, Mona Vale Road, 18 km NNW. of Sydney, 151° 10′E, 33° 42′S, alt. c. 150 m, 14.iv.1984, *Archer 1667.* (Holotype: MEL 1047761. Isotype: CBG, H, NSW).

Also Examined:

*Western Australia* — Point Mount Henry, Manning, 27.vi.1970, *N. Sammy* (PERTH NS840894); near Princes Royal Harbour, 18.vi.1980, ? coll. (PERTH 000828).

*South Australia* — Yorke Peninsula, 7 km W. of Ardrossan, 30.viii.1977, *J. A. Elix 3728* (ANUC); 19 km E. of Stenhouse Bay, alt. 16 m, 31.viii.1977, *J. A. Elix 3755* (ANUC).

*Queensland* — Nerang River, Numinbah Valley, alt. 120 m, 20.viii.1976, *J. A. Elix 2548* (ANUC).
*New South Wales* (selected specimens only, 5/39) — Sutherland, ix.1906, *Townsend* (NSW); Gladesville, 30.vii.1911, *M. Flockton* (NSW); Batehaven, 0.5 km W. of Surf Beach, 14.ix.1975, *J. A. Elix 1241* (MEL 1017175); near Mt Dowe, alt. 1550 m, 12.x.1981, *Archer 1160* (NSW); Twofold Bay, no date, *White* (MEL 6526).
*Australian Capital Territory* — Honeysuckle Creek, 30 km SSW. of Canberra, alt. 1100 m, 2.iv.1983, *Archer 1479A* (MEL 1047764).
*Victoria* — Kew, 29.iii.1886, *F. Wilson* (NSW); Narbethong, -.vii.1906, *Mrs Goodyear* (NSW); Nug Nug, 50 km SE. of Wangaratta, 18.xi.1979, *Archer 791* (CBG, MEL 1047763); 8 km E. of Tawonga, alt. c. 700 m, 22.xi.1979, *Archer 860* (MEL 1047762).
*New Zealand: North Island* — Auckland, Waitakere Coast, alt. 25 m, 27.x.1983, *J. K. Bartlett 27057, 27058* (WELT); Mt Te Aroha, alt. c. 1000 m, 27.iii.1982, *J. K. Bartlett 28271* (WELT).

DISCUSSION:

The three varieties of *Cladonia sulcata* referred to above differ in chemistry and distribution. Var. *wilsonii* and var. *striata* are examples of chemosyndromic variation (Elix 1982; Elix *et al* 1984; Hawksworth and Hill 1984); the minor compound norstictic acid in var. *wilsonii* becomes a major compound in var. *striata* and the minor compound stictic acid in var. *striata* becomes a major compound in var. *wilsonii*. This type of chemical variation has been given taxonomic recognition at the species level (Elix 1981), e.g. *Parmelia amphixantha* Müll. Arg. with usnic and stictic acids and *P. pseudoamphixantha* Elix with usnic and norstictic acids, but Hawksworth (1976) proposed that, where one substance was replaced by a biogenetically closely related substance and this replacement was correlated with geographical differences, the chemical variations be given recognition as varieties, i.e. category 2B, *vide supra*. This proposal has been followed here. Both varieties occur in mainland Australia but var. *wilsonii* has a more southerly distribution whereas var. *striata* has a more northerly distribution and does not occur in Tasmania or the South Island of New Zealand. *C. sulcata* lacks the corymbose form of the somewhat similar *C. corymbescens* Nyl. ex Leighton and is further distinguished from that species by the absence of fumarprotocetraric acid.

*C. sulcata* var. *striata* contains atranorin and norstictic and bourgeanic acids, together with traces of stictic, cryptostictic and constictic acids. The presence of bourgeanic acid and the small apothecia differentiate *C. sulcata* from the Northern Hemisphere *C. cariosa* (Ach.) Sprengel. The preferred habitat of *C. sulcata* is on soil in semi-exposed positions; it has not been found growing on wood.

*C. sulcata* var. *striata* has been referred to previously as *Cladonia diffissa* (Wilson 1889; Cheel 1914; Archer 1982, 1984), based on *C. cariosa* var. *diffissa* (Wilson 1889a), but the holotype of this last taxon is *C. enantia* Nyl. (Archer 1986).

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